

Posterolateral Corner Knee Injuries: Review of Anatomy and Clinical Evaluation

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Financial Disclosures:
None reported.

Support: None reported.

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Submitted June 3, 2015;
revision received August 10, 2015;
accepted August 20, 2015.

The structures in the posterolateral corner of the knee, which stabilize the joint, are often involved in injuries to the posterior cruciate ligament. Familiar structures include the anterior cruciate ligament, posterior cruciate ligament, tibial collateral ligament, and menisci. Less familiar are the structures of the posterolateral corner, the most important of which are the fibular collateral ligament, popliteus tendon, and popliteofibular ligament, which resist varus angulation, external rotation, or posterior translation of the tibia. Injury to the posterolateral corner can be assessed with the posterolateral drawer, dial, reverse pivot shift, external rotation recurvatum, and varus stress tests. The purpose of this review is to highlight the posterolateral corner of the knee and injuries to its structures so that physicians can more accurately diagnose these injuries and provide appropriate treatment. Management focuses on restoring the fibular collateral ligament, popliteofibular ligament, and, in certain cases, the popliteus tendon.

J Am Osteopath Assoc. 2015;115(12):725-731
doi:10.7556/jaoa.2015.148

Injuries to the posterolateral corner of the knee have become increasingly studied in orthopedics during the past 10 to 15 years. Injuries in this area are often associated with injuries to other ligamentous structures of the knee, particularly the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL). The posterolateral corner of the knee contains a variety of structures, some of which are inconstantly present.^{1,2} Although most physicians are familiar with the ACL, PCL, fibular collateral ligament (FCL), tibial collateral ligament (TCL), and menisci, fewer are familiar with the structures of the posterolateral corner and the methods by which injuries to the area can be detected. We review the anatomy of the posterolateral corner, the clinical evaluation of these structures, and treatment methods to address injuries to this area.

Anatomy

The knee is a complex joint consisting of a capsule, ligaments, cartilage, tendons, and bony surfaces that keep the femur aligned with the tibia. The *eFigure* shows the 10 components that comprise the posterolateral corner of the knee: FCL, lateral head of gastrocnemius, fabella bone in the lateral head of the gastrocnemius tendon (if present), fabellofibular ligament (if fabella is present), popliteofibular ligament (PFL), popliteus tendon, biceps femoris tendon, iliotibial tract, conjoint tendon, and arcuate ligament.³ All of these components help prevent posterior translation of the tibia relative to the femur and also help prevent excessive external rotation and medial deviation (varus angulation) of the tibia.

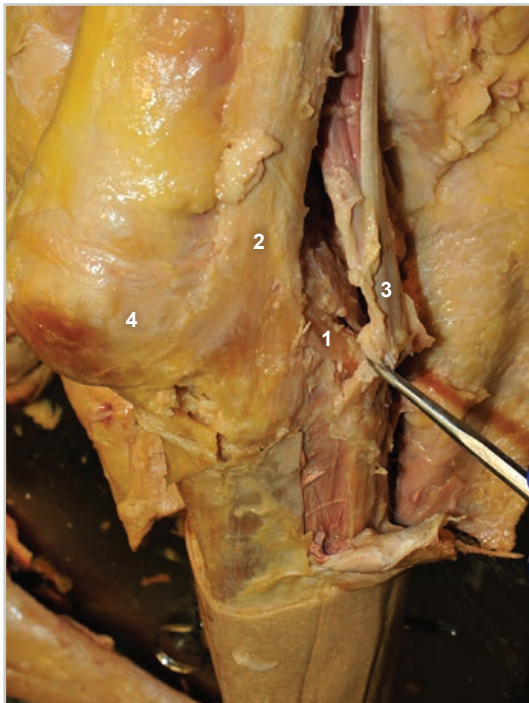


Figure 1. Superficial lateral knee dissection. Left knee, anterolateral view. 1, Fibular collateral ligament; 2, iliotibial band; 3, biceps femoris tendon; 4, lateral aspect of the patella.

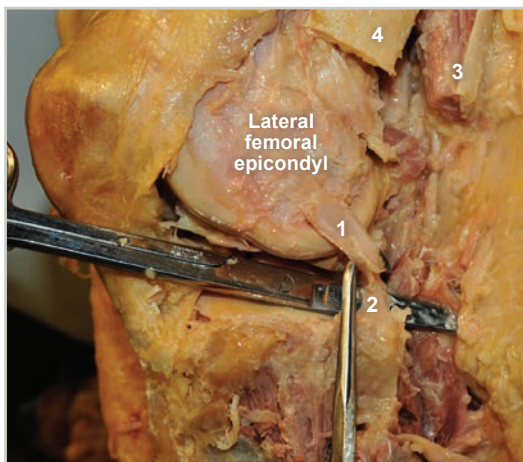


Figure 2. Deep lateral knee dissection. Left knee, lateral view. 1, Popliteus tendon; 2, popliteofibular ligament; 3, cut portion of biceps femoris muscle and tendon; 4, cut portion of iliotibial band.

The FCL, shown in *Figure 1*, stretches from the posterolateral aspect of the femoral condyle, anterior to the origin of the lateral head of gastrocnemius, and joins with the tendon of the biceps femoris to form the conjoint tendon inserting on the fibular head.³⁻⁵ It functions primarily to prevent varus angulation of the leg relative to the femur, particularly between 5° and 25° of flexion. The FCL also helps prevent internal rotation of the knee.^{4,6,7} The PFL, shown in *Figure 2*, extends from the musculotendinous junction of the popliteus muscle to insert onto the head of the fibula. This ligament is tense during extension of the knee; in this position, it is the main structure that prevents excessive external rotation.^{3-6,8,9} If the FCL is absent or ruptured, the PFL becomes more prominent in limiting varus angulation of the leg.⁸

The popliteus tendon, also shown in *Figure 1*, originates at the lateral condyle of the femur, just superior to the knee's articular surface and capsule. From there it runs deep to the FCL and arcuate ligament, to insert on the proximal 10 to 20 cm of the posterior surface of the tibia superior to the popliteal line.^{4,6} A small portion of the popliteus may originate from the posterior horn of the lateral meniscus. It is the primary dynamic lateral stabilizer of the knee, and its primary function is to internally rotate the leg by pulling the posteromedial aspect of the tibia toward the lateral side of the distal femur.^{3,5,6} Because contraction of this muscle internally rotates the leg, it also prevents excessive external rotation of the leg, particularly when the knee is in flexion. Contraction of the popliteus muscle helps unlock the knee from full extension. It also assists in preventing varus angulation and posterior translation of the tibia relative to the femur.^{3,5,6} The arcuate ligament, shown in *Figure 3*, is a variably present structure found superficial to the popliteus tendon, and it helps prevent external rotation and varus angulation of the leg.^{6,10} However, the majority of sources indicate that the arcuate ligament has a minor role in providing stability to the posterolateral corner.^{6,7,9,11}

The lateral head of the gastrocnemius muscle originates from the posterior aspect of the lateral epicondyle

of the femur and joins the medial head of the gastrocnemius, soleus, and plantaris muscles to create the calcaneal (Achilles) tendon, which inserts on the calcaneal tuberosity. In addition to being a major plantar-flexor of the foot, especially when the knee is extended, the lateral head of the gastrocnemius muscle also stabilizes the posterolateral aspect of the knee. The fabella is a variably present (10%-30%) sesamoid bone that is found in the lateral head of the gastrocnemius.³ When the fabella is present, the fabellofibular ligament extends from its anterior surface to the head of the fibula.

The tendon of the biceps femoris inserts into the anterolateral aspect of the head of the fibula. As the biceps femoris tendon inserts into the fibula, it fuses with the FCL, forming a conjoint tendon. Also on the lateral side of the knee but anterior to the tendon of the biceps femoris, the iliotibial tract, shown in *Figure 1*, is a thickened back of the fascia lata that transmits the forces generated by the gluteus maximus and tensor fascia lata muscles to the leg. It inserts onto the anterolateral tubercle of the tibia, stabilizing the knee's anterolateral aspect. The structures of primary importance to the function and stability of the posterolateral corner are the FCL, popliteus tendon, and PFL.² Injury to the posterolateral corner of the knee is usually associated with other ligamentous knee injuries, particularly the PCL and ACL.^{6,7,12}

Clinical Evaluation

Several studies have weighed in on the ranges of translation that equate to the amount of injury involving ligaments of the knee. Knee ligament injuries can be graded on a scale from 0 to III,^{5,7,13,14} as follows:

- **Grade 0:** normal ligament without injury
- **Grade I:** sprain, with localized joint pain and tenderness but with no real laxity; associated with 0 to 5 mm of translation
- **Grade II:** a partial or complete tear of a single ligament with detectable joint laxity and a good

end point; localized pain and tenderness; between 5 and 10 mm of translation

- **Grade III:** complete tear of a single ligament, with gross laxity and instability; greater than 10 mm of translation, possibly including additional ligament injuries

An isolated PCL injury cannot be clinically determined to be a grade III injury unless ligamentous injury of the posterolateral corner is also involved.^{13,15}

Common causes of posterolateral corner knee injury include a posterolateral blow to the anteromedial portion of the tibia, a blow to a flexed knee that forces it into varus angulation, contact and noncontact injuries to a hyperextended knee, or knee dislocations. Any injury that may hyperextend, externally rotate, or force the tibia into a varus angle (eg, motor vehicle collisions, falls, sporting injuries) may involve the posterolateral corner.^{7,16,17} Once the mechanism of injury has been established, the next step is to conduct a thorough focused examination of the knee, including the posterolateral corner, to determine the amount of ligamentous injury.

When a posterolateral corner injury is suspected, in addition to a visual and palpatory examination, anterior/posterior drawer test, and varus/valgus stress test, more focused examinations should be done, such as the posterolateral drawer test, dial test, reverse pivot shift test, external rotation recurvatum test, and varus stress test.^{2,4,5,7,14} Physicians must always examine both knees to assess the individual variation in structural laxity before determining that a definite difference between the knees exists. The examination findings are considered positive if 1 knee is different from the other; if both knees are the same, the result is considered negative unless it is proven that both knees have sustained the same injury.

Posterolateral Drawer Test

During a posterolateral drawer test, the patient assumes a supine position. The examiner flexes the patient's hip to 45°, flexes the knee to 80°, externally rotates the leg 15°,



Figure 3. Posterior knee dissection. Right knee, posterior view. 1, Popliteus muscle; 2, arcuate ligament; 3, head of fibula.

and then applies a force directed posterior with external rotation.^{4,5,7,16} A positive result for PCL injury is indicated by clinically significant posterolateral translation movement on one side. The amount of posterolateral translation involved can help determine the grade of the injury.

Dial Test

Isolated injuries of the posterolateral corner as well as injuries that affect the posterolateral corner and the PCL are assessed with the dial test.^{2,4,5,7,14} The test is performed with the patient lying prone with the knees flexed to 90° and heels together. External rotation of the legs is determined by observing the position of each foot. The test is repeated with the knees flexed to 30°.^{4,5,7} A result positive for a posterolateral corner injury in combination with a PCL injury is indicated if greater than 10° of asymmetry is seen between the right and left foot at both 30° and 90°

of flexion.^{4,5,7,14} The test result is considered positive for an isolated posterolateral corner injury if greater than 10° of asymmetry is present with the knees at 30° of flexion but not at 90°. Variations of this test can be performed with the patient in a supine posture.

Reverse Pivot Shift Test

Usually done under anesthesia to prevent the patient from guarding, the reverse pivot shift test is performed with the patient in a supine position. The examiner flexes the knee to 90° with external rotation and varus stress applied to the knee.^{2,4-7} The knee is then brought into extension, which allows the tibia to come from a posterior subluxed position at roughly 20° of flexion to a reduced position in full extension. A palpable shift or “clunk” during this extension indicates damage to the posterolateral corner.⁴⁻⁷

External Rotation Recurvatum Test

Also completed under anesthesia to prevent the patient from guarding, the external rotation recurvatum test is done with the patient supine. The examiner lifts the patient’s affected leg up by the toes only, and a positive result is confirmed when the lower leg falls into external rotation and recurvatum (bending backward at the knee); this finding likely indicates a posterolateral corner injury.^{4,5,7,16}

Varus Stress Test

With the patient lying supine, the varus stress test is done with the examiner applying a varus force to the knee at 0° and 30° of flexion.^{2,4,5,7} This test can differentiate between isolated FCL injuries and injuries involving the FCL as well as the PCL or ACL.³⁻⁷ Measurable varus laxity at 0° of flexion indicates that the injury involves the FCL and the PCL or ACL. Varus laxity at 30° of flexion indicates that the injury involves the FCL.³⁻⁷

Imaging

The aforementioned tests provide information regarding the structures that have been injured. Even though most

physicians will be able to diagnose the isolated and combined injuries on the basis of clinical examination findings, they will likely use magnetic resonance imaging to verify the clinical diagnosis before the patient begins physical therapy or pursues surgical options. The FCL and PFL can be seen on axial, sagittal, and coronal magnetic resonance imaging. The PFL is best visualized with a coronal oblique view.¹⁷ The popliteus muscle can be seen in both axial and coronal cross-sections. The biceps tendon and its relationship to the fibular head is most visible in coronal section, as is the fabellofibular ligament, if it is present.¹⁷ The arcuate ligament is difficult to visualize but can sometimes be seen on axial view.¹⁷ The arcuate sign, which can be seen on magnetic resonance imaging, is an avulsion fracture involving the fibular head at the distal attachment site of the FCL and is indicative of posterolateral corner injury.^{6,18} The PFL and arcuate ligament also attach to the head of the fibula and may be involved in such an avulsion fracture.^{3,19}

Management of Injuries

The extent of injury determines the management strategy. As with other ligament injuries, grade I and II injuries of the posterolateral corner are usually managed conservatively with physical therapy, rest, and exercises to strengthen the surrounding structures and thus provide greater stability to the knee.^{6,7,12} Within the first week after the injury, inflammation can be minimized with rest, ice, compression, and elevation, as well as the temporary use of crutches. Once swelling and edema have decreased, strengthening the quadriceps muscle with physical therapy will help compensate for the PCL injury. Osteopathic considerations after initial pain management can incorporate several techniques. Swelling of the area can be eased with indirect myofascial release, pedal pump, and use of the knee percussion vibrator. Knee pain and range of motion can be improved using posterior cruciate counterstrain, and lymphatic drainage from the injured area can be addressed with myofascial release and pedal pump.²⁰

Surgical repair is usually necessary with grade III ligament injuries or multiligament injuries.^{2,6,7,12,14} Because the posterolateral corner contains multiple structures, a few concerns exist related to their reconstruction. Much of the literature indicates that in the setting of an injury to the posterolateral corner combined with the PCL and ACL, all of the structures should be repaired at the same time to provide a construct that will reestablish posterior and anterior stability along with external rotation stability.^{6,7,9,12,21,22} When the posterolateral corner is not repaired in conjunction with the ACL or PCL, increased rates of failure and continued discomfort with instability, primarily with external rotation of the knee, occur.^{6,7,9,12,21,22} During reconstruction of the PCL, a surgeon can usually improve it to 1 grade better than it was before the operation. For example, a grade III PCL injury can be restored to the equivalent of a grade II PCL injury but no better.^{12,22} Another important consideration is how recently the injury occurred. Many reports indicate that injuries that are managed within 2 to 3 months of the inciting event tend to do better after reconstruction compared with those managed several months or years later.^{4,6,7,12,23,24}

The consensus in reconstruction of the posterolateral corner is to focus on the FCL, PFL, and popliteus tendon.^{2,4-7,11} Although several types of reconstruction that attempt this end have been developed, none has yet shown results comparable to the outcomes of other routine knee ligament reconstructions.² When a surgeon repairs the posterolateral corner, he or she must first evaluate which of the structures are damaged and proceed accordingly. Most of the literature in this area recommends repairing the FCL, PFL, and popliteus tendon if they are disrupted.^{1,2,6-9,12,22,23} One study²⁵ described a posterolateral corner reconstruction with and without repairing the popliteus tendon. The authors found no difference in knee stability when comparing the 2 reconstructions, which may indicate that it is not necessary to reconstruct the popliteus tendon.²⁵ Surgeons should note whether the injury is chronic. If so, and the patient elects to undergo the reconstruction, full-length standing radiographs

should be taken to determine whether a varus deformity is present. In cases of a varus deformity, surgeons may opt to perform a high tibial osteotomy.^{4,5} Surgical reconstruction of the posterolateral corner is a constantly evolving aspect of this injury.² Currently, the preferred surgical method is to use either the calcaneal (Achilles) or semitendinosus tendon grafts to concurrently reconstruct the FCL, PFL, and popliteus tendon.^{1,6-9,11,12,14,22,23,26,27} As research continues to be done and more outcomes are evaluated, surgical reconstruction of the posterolateral corner of the knee will improve and become as precise a reconstruction as with other ligaments of the knee. Eventually, research will progress to trustworthy meta-analyses regarding repair or exclusion of the posterolateral corner structures during repair of the PCL.

Discussion

Although orthopedic surgeons repair these structures of the knee, knowledge of the posterolateral corner of the knee can positively affect patient care in other clinical settings. Knowledge of the normal structure and function will assist physicians in using the appropriate examinations and imaging modalities to accurately diagnose injuries in this region. Whereas the FCL and popliteus tendon are commonly taught during gross anatomy courses in medical school, the PFL is rarely dissected or emphasized. In addition to those 3 major structures, more variable structures such as the arcuate and fabellofibular ligaments are relatively unknown outside those who specialize in knee injury because of their inconstancy. More research on their incidence and normal function may elucidate how their presence affects physical therapy or surgical reconstruction of the knee. Although therapy and exercise can go a long way in keeping a knee stable, ruptured ligaments often require surgical intervention. Such interventions should attempt to restore the area to its normal structure and function as much as possible.

Evaluating the 3 major structures of the posterolateral corner (FCL, PFL, and popliteus tendon) in the presence

of a PCL-deficient knee will help provide information regarding which of the structures, or a combination thereof, provide the most stability to the knee without a PCL. Little evidence exists in the literature that indicates which of these structures is the most important on the basis of clinical examination results and biomechanics. Studies should use the primary physical examination techniques previously described, along with a dissection and release of individual structures and reevaluation to determine the amount of stability each structure provides. Research in this area will help guide surgical reconstruction of the posterolateral corner to reestablish normal function and increase surgical success rates.

Acknowledgments

We thank those who donated their bodies for the purpose of medical education and research without whom this work could not have taken place. We also thank the reviewers whose conscientious work improved this article.

Author Contributions

Drs Schweller and Ward provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; Drs Schweller and Ward drafted the article or revised it critically multiple times for important intellectual content; Drs Schweller and Ward gave final approval of the version of the article to be published; and Drs Schweller and Ward agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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