POSTEROLATERAL CORNER INJURIES OF THE KNEE

Abstract

The posterolateral region of the knee is an anatomically complex area that plays an important role in the stabilization of the knee.

Important to understand the anatomy and the function of posterolateral structures in knee stabilization and kinematics.

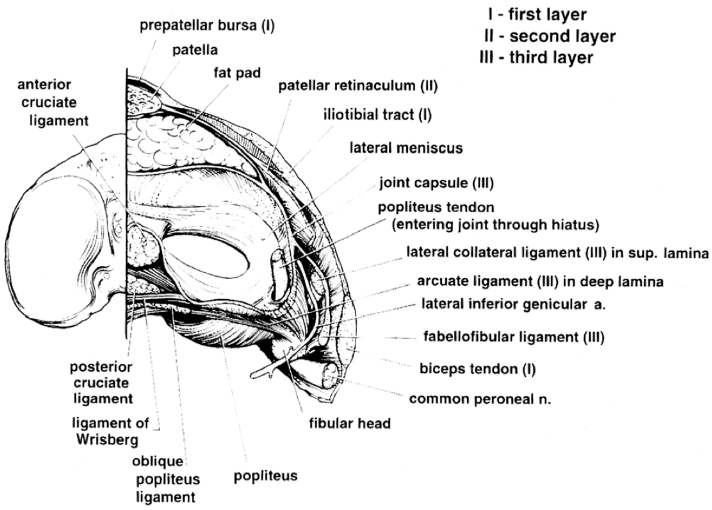
Through sectioning and loading studies, the posterolateral corner has been shown to play a role in the prevention of varus angulation, external rotation, and posterior translation.

The potential for long-term disability from these injuries may be related to increased articular pressure and chondral degeneration. [mainly in the medial compartment]

The failure of the reconstruction of cruciate ligaments may be due to unrecognized or untreated posterolateral corner injuries. Various methods of repair and reconstruction have been described and new research is yielding superior results from reconstruction of this region.

Anatomy and Functional Biomechanics

Seebacher: Detailed layer concept by dividing the structures into three layers, akin to the medial aspect of the knee.



I Iliotibial tract (ITT) and the biceps femoris.

II Quadriceps retinaculum, Patellofemoral ligaments

III Superficial: LCL, Fabello-fibular ligament

Deep: Popliteofibular ligament (PFL),

Arcuate ligament

Popliteus tendon complex

I

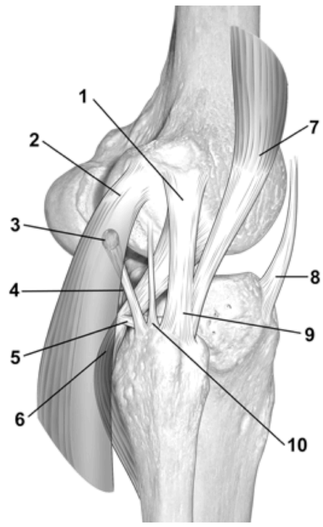
Deep Anatomy

Major components of posterolateral corner
1. LCL
2. Lateral head of gastro
3. Fabella
4. Fabellofibular ligament
5. Popliteofibular ligament [PFL]
6. Popliteus tendon
7. Biceps femoris tendon
8. Iliotibial tract
9. Conjoint tendon
10. Arcuate ligament [AL]

The LCL

origin The lateral distal femoral condyle [posterior to popliteus}

insertion Lateral aspect of the fibular head. [distal to AL, PFL]



The popliteus

origin From the posterior aspect of the proximal tibia and passes through a hiatus in the coronary ligament

Insertion The lateral femoral condyle, inferior to the LCL origin.

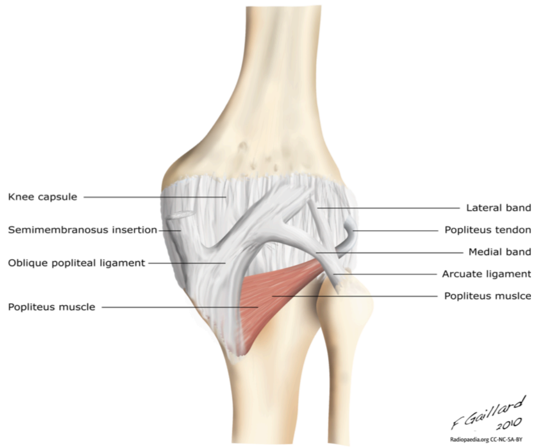
In 20% of the population have attachments between the popliteus tendon and the lateral meniscus.

The PFL connects the popliteus tendon to the posterior, proximal region of the fibular head. Its critical role in posterolateral stability has been extrapolated by recent research.

The arcuate ligament is a Y-shaped ligament with medial and lateral limbs. They form the fascial condensation over the posterior popliteus tendon.

Only the arcuate ligament in 13% of knees reinforced the posterolateral region of the knee and the fabellofibular ligament was the sole reinforcement in 20%. The investigators noted that 67% of knees had both structures.

The biceps femoris posterolateral corner of the knee has given researchers and functions to provide dynamic lateral stabilization.



Function

The LCL	A primary restraint to varus angulation [all angles] A secondary restraint to external rotation and posterior displacement.
Rest of the postero-lateral structures	Is greatest at 30° of knee flexion.
PFL	Resists excessive posterior translation, varus angulation, and external rotation.

The posterolateral structures experience increased forces when the PCL is compromised. Under posterior tibial load, the forces in the posterolateral structures increase from the intact state to the PCL-deficient state. In the intact knee, the forces decrease as the knee is flexed, which corresponds to the increased contribution of the PCL in high angles of flexion. After sectioning the PCL, the posterolateral structures experience increased forces at all levels of flexion. Under these conditions, the popliteus muscle acts as a major stabilizer.

Clinical Relevance

A. Isolated PCL injuries have long been thought to be clinically insignificant. With these injuries, there is an increase in posterior translation, which increases on higher knee flexion; however, there is no increase in varus laxity or external rotation.
B. Isolated LCL tears demonstrate increased varus laxity is greatest at 30°
C. Injury to all of the posterolateral structures, with the PCL remaining intact, demonstrates maximally increased varus, external rotation, and posterior translation at 30° of knee flexion. As the knee is flexed up to 90°, the majority of PCL fibers become taut, and there is some secondary restraint to varus and external rotation. At 90° of flexion, there is primary restraint to posterior translation.
D. When the PCL and the posterolateral structures are torn, the effect of the PCL at high angles of flexion is lost, and the knee experiences decreased restraint to varus, external rotation, and posterior translation at all angles of flexion.
E. When ACL injuries are combined with posterolateral corner injuries, the knee may experience increases in anterior and posterior translation, varus, coupled external rotation, and primary internal rotation.

LCL alone	Varus at 30°
PL lesion with intact PCL	30° Varus test, more instability in external rotation than internal
PL and PCL deficit	Unstable at 30° and 90°: both in internal and external rotatation.

In relation to ACL reconstruction, O'Brien demonstrated the most common cause of failure of ACL reconstruction was unrecognized or untreated posterolateral rotatory instability.

Joint pressure studies

Articular pressure also increases with ligament sectioning. Combined sectioning of the PCL and posterolateral complex increases patellofemoral pressures. Additionally, the posterior subluxation of the tibia, or "drop back," leads to increased quadriceps contraction required to extend the knee. Further, PCL sectioning leads to increased medial compartment pressures.

Mechanism of Injury

Acute isolated posterolateral knee injuries are extremely rare and represent less than 2% of all ligamentous knee injuries. The majority of these injuries occur as part of a combined injury pattern. The mechanism of injury usually relates to contact or noncontact mechanisms.

Contact, or direct, injuries are due to sports (40%) or motor vehicle accidents. A posterolaterally directed force is exerted onto the proximal medial tibia, causing knee hyperextension with varus and external rotation.

Foot position may also play an important role. With the ankle in dorsiflexion, a fall results in the majority of the force moving through the patella; however, with plantarflexion, the proximal tibia strikes the ground or object.

Posterolateral corner injuries are rarely isolated. Concurrent ligamentous injury rate has been shown to range from 29% to 80%. MRI have revealed the potential for internal derangements of the knee that include both meniscal tears (29%) and osteochondral lesions (36%).

Examination

1. Complaints of pain, effusion
2. May have gross deformity if a knee dislocation.
3. Ecchymosis or skin abrasions on the anteromedial proximal tibia may be signs of a posterolateral injury.
4. Motor or sensory symptoms in peroneal nerve distribution in 20%
5. Pulses and ankle-brachial indices (ABI)
6. Chronic stage: likely cause instability. Difficulty with lateral movements or cutting activities.

The physical examination:

Overall limb alignment, limb length, and gait pattern.

Varus malalignment of the extremity may not only predispose a person to posterolateral corner injury, but may lead to failure of treatment as well.

With full extension or gait, the knee may buckle into hyperextension. Due to this instability, patients may ambulate with the knee in a flexed position.

Patients also hold the ankle in equinus to prevent the knee from reaching full extension. A lateral or varus knee thrust may be visible.

Tests:

The anterior and posterior drawer and Lachman tests are designed to evaluate the integrity of the cruciate ligaments.

If either the PCL or posterolateral corner is injured, the knee may have assumed a posteriorly subluxed position. This posterior

resting position also leads to anterior translation of the tibia with quadriceps contraction, known as the quadriceps active test. The normal knee does not demonstrate this motion.
The posterior drawer can be used to evaluate the PCL if done with the knee at 90° of flexion. At 30° of flexion, the test can be used to evaluate the posterolateral corner.

Varus and valgus laxity testing should be performed in full extension and then at 30° of flexion to isolate the collateral ligaments. Since the posterolateral corner resists posterior translation, external rotation, and varus at lower degrees of knee flexion, some combination of these movements are present in the individualized tests.

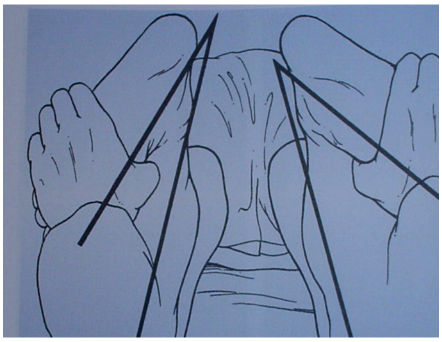
Posterolateral instability test

1. Posterior drawer with the leg in 15° externally rotated: force causes the lateral tibia plateau to move while the medial; plateau does not translate.
2. The external rotation recurvatum test is performed by lifting the extremity by the great toe. A knee with a posterolateral corner injury should fall into hyperextension, varus, and external rotation.[3]

3. The posterior external rotation test is a combination of a posterior force and an external rotation force, performed at 30° and 90° of knee flexion. Positive results at 30° indicate a posterolateral corner injury; however, positive results at 90° may be indicative of combined posterolateral corner and PCL injuries.

4. Jakob described the reverse pivot shift test as taking the knee from 90° to 0° with a valgus load applied. The leg is held in external rotation and a clunk is felt similar to that of a pivot shift for an ACL injury.

5. The tibial external rotation test, or dial test, is performed at 30° and 90° of knee flexion. A supine or prone body position can be used. The relationship of the medial aspect of the foot to the femoral axis is examined. The values more than 10° compared to opposite knee is significant.



6. Instrumented devices may also allow for objective measures of instability. The KT-2000 device is available.

Normal side-to-side variation is, approximately, 4.4° at 90° of knee flexion and 5.5° at 30° of flexion.[45]

Radiographic Evaluation

Posterior sag
Avulsion fractures are not uncommon and may indicate ligamentous injury.
An arcuate fracture, or avulsion of the fibular head
Compression injuries may also be visible, particularly on the tibial plateau.
A widening of the lateral joint space may also be visible.

MRI

Posterolateral knee injuries often will show bone edema on the anteromedial aspect of the lateral femoral condyle.

This pattern of edema was present in all cases of combined PCL and posterolateral corner knee injuries.

The size of the fibular styloid fracture may also indicate the severity of injury.

Given the various anatomical ligament insertions, the particular area of the fibular head that is avulsed may indicate which ligaments are injured.

Small avulsions with medial edema likely represent arcuate or PFL injury. Larger avulsions with diffuse proximal fibular edema correlate with LCL and possibly biceps femoris injuries.

Grading

Various grading systems have been used to describe injuries to the posterolateral corner of the knee. LCL laxity can be referred to as grade I if there is 0 mm to 5 mm of opening compared to the normal side. Grade II injuries demonstrate 6 mm to 10 mm of opening, while grade III injuries have greater than 10 mm of opening and no firm endpoint. The standard nomenclature of athletic injuries has also been applied to the posterolateral corner. Grade I represents minimal tearing of a ligament with no abnormal motion. Grade II injuries have partial tearing with slight or moderate abnormal motion. Grade III injuries demonstrate complete tearing with marked abnormal movement.

Treatment

The treatment of posterolateral corner injury is difficult to assess given the unknown natural history of such injuries. It can be safe to assume that grade I and II injuries should be managed nonoperatively. Progressive range of motion and strengthening exercises should begin afterwards.

Clinically, Kannus has also shown that complete tears have poor functional outcomes. Gait abnormalities and increases in articular pressure have led many surgeons to suggest operative intervention for these injuries. The indications for surgery include symptomatic instability with functional limitations, supplemented by objective physical findings. These may include a 2+ varus opening at 30° of knee flexion, a positive external rotation recurvatum test, a posterolateral external rotation test, and an increased tibial external rotation test, such as demonstrated by the dial test.

a. The principles of treatment of acute injuries

Repair the concurrent treatment of cruciate injuries.

Any varus deformity: Correct

Advancement or repair of these structures or augmentation with either autograft or allograft.

Reconstruction can be anatomic or nonanatomic.

Timing: Intervention within the first 3 weeks has been suggested.

Approach: A lateral approach to the knee. The incision begins on the distal lateral thigh and extends toward the region between Gerdy's tubercle and the fibular head. The fascial interval is between the IT band and the short head of the biceps femoris.

The results of direct repair are best when treating avulsions.

Post op: The knee is kept in about 60° of flexion with slight internal rotation of the tibia.

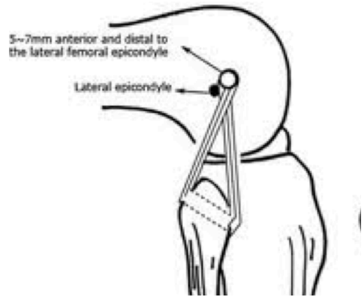
Results: 85% good subjective results and 77% good objective results.

Augmentation can be used when there is attenuated tissue. Slips of the iliotibial band (ITB) or biceps can be used to augment the popliteofibular or popliteus ligaments, respectively.

Advancements of the entire posterolateral complex have been described, both proximal and distal. The complex is moved proximally in line with the LCL, fixed to a point anterior to the center of rotation of the knee, and tightened in 30° of flexion with the tibia in neutral. The results of this procedure have been mixed. Hughston and Jacobsen,[4] in a study of 96 patients using distal anterior advancement, had 85% good objective results, 78% good subjective results, and 80% good functional results.

Reconstruction techniques use either autograft or allograft. Local autograft donor sites include the central third of the biceps tendon, the iliotibial band, hamstring tendons, and bone-patellar tendon-bone complex. The reconstruction may be either an attempt to anatomically recreate the relevant structures or to recreate the function of the posterolateral corner with alternate structures or techniques.

Nonanatomic techniques include the biceps tenodesis and the posterolateral sling procedure. With the biceps tenodesis technique, the biceps tendon is fastened down to the lateral femoral condyle to a point 1 cm anterior to the epicondyle. Clancy demonstrated 90% good results at 2 years .



The posterolateral sling procedure recreates the function of the posterolateral structures by passing a graft through an anterior-posterior tunnel in the lateral aspect of the proximal tibial plateau. The graft exits anterior to both the lateral gastrocnemius and popliteus and is secured to the LCL origin.

Latimer bone patellar tendon-bone construct for LCL insufficiency in which one aspect of the graft is fixed to the isometric point of the lateral femoral condyle; the other graft end is inserted into the fibular head.

These surgeries are not without complications. Peroneal nerve injuries, vascular injuries, and hamstring weakness have been described. Infection, hardware irritation, arthrofibrosis, and stiffness may also occur.

Summary

Injuries to the posterolateral corner of the knee remain a difficult entity.

The diagnosis requires a high degree of suspicion as well as a thorough knowledge of the functional anatomy of the knee and lower extremity.

A detailed clinical examination in various degrees of knee flexion with comparison to the uninjured extremity will often aid in the diagnosis.

MRI will help as well although specifically oriented views may be necessary.

The treatment of posterolateral corner injuries often requires surgical intervention, particularly if there is a combined ligamentous injury pattern. Recent studies have demonstrated that primary reconstruction may yield better results than repair. Individual clinical scenarios can be evaluated better with knowledge of the various techniques as well as the recent comparative outcomes of those techniques.

Role of upper tibial osteotomy

High tibial osteotomy (HTO) is a surgical procedure used to change the mechanical weight-bearing axis and alter the loads carried through the knee.

Conventional indications for HTO are medial compartment osteoarthritis and varus malalignment of the knee causing pain and dysfunction.

Today the indications include patients with chronic ligament deficiencies and malalignment, because an HTO procedure can change not only the coronal but also the sagittal plane of the knee.

Indeed, decreased posterior tibial slope causes posterior tibia translation and helps the anterior cruciate ligament (ACL)-deficient knee. Vice versa, increased tibial slope causes anterior tibia translation and helps the posterior cruciate ligament (PCL)-deficient knee.

A review of literature shows that soft tissue procedures alone are often unsatisfactory for chronic posterior instability if alignment is not corrected. Since limb alignment is the most important factor to consider in lower limb reconstructive surgery, diagnosis and treatment of limb malalignment should not be ignored in management of chronic ligamentous instabilities.

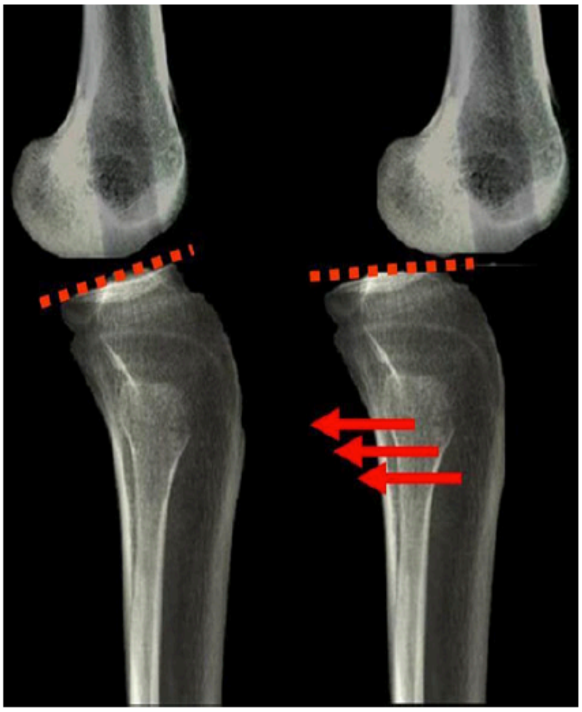


Fig. 2 Closing wedge HTO causes a decrease in posterior tibial slope, and posterior translation of the tibia; it stabilizes a knee with anterior instability

Fig. 3 Opening wedge HTO causes an increase in posterior tib slope, and anterior translation of the tibia; it stabilizes a knee w posterior instability

HTO is an effective and reliable procedure for treatment of the PCL/PLC-deficient knee associated with varus malalignment. In a chronic instability, if the knee is unstable even after osteotomy, soft tissue procedures should be performed 6–8 months after correction of the malalignment. HTO allows the surgeon to modify both the coronal and the sagittal plane of the knee; an increased posterior tibial slope stabilizes the joint, and reduces forces on posterolateral structures and on posterior articular cartilage.

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