Physical Examination and Imaging of the Lateral Collateral Ligament and Posterolateral Corner of the Knee

Michael S. Bahk, MD and Andrew J. Cosgarea, MD

Abstract: Diagnosis of posterolateral corner injuries can be challenging. Understanding the mechanism of injury in combination with careful history taking and a thorough physical examination are crucial. Clinical findings may be subtle, especially in the acute setting. Specialized tests such as external rotation recurvatum test, posterolateral drawer test, reverse pivot shift test, and dial test are particularly helpful. A characteristic radiographic finding is the arcuate sign, whereas medial Segond fractures can be associated with posterolateral corner injuries. Magnetic resonance imaging is most useful when performed with a high strength magnet utilizing a coronal oblique technique. Prompt and accurate diagnosis of posterolateral corner injuries allows the orthopedist to initiate the appropriate repair and reconstruction procedures to assure optimum treatment results.

Key Words: posterolateral corner, lateral collateral ligament, arcuate sign, medial Segond fracture, dial test, external rotation recurvatum test

Injuries of the posterolateral corner are significant sources of disability that can be difficult to diagnose. Historically, posterolateral corner injuries were often missed. Recent research has improved the awareness of this clinical entity. The anatomy of the posterolateral corner is complex, and the literature is obscured with conflicting terms. Anatomic and biomechanical studies in the past decade have helped identify key components of the posterolateral corner and aided increasing clinical recognition. However, proper timely diagnosis of posterolateral corner injuries requires a high level of suspicion coupled with careful clinical examination and appropriate imaging studies.

Posterolateral corner injuries can produce considerable disability. Significant injuries result in lateral instability and gait abnormalities. Without the static stabilizers of the posterolateral corner, the convex surfaces of the lateral femoral condyle and lateral tibial plateau may result in lateral opening with heel strike producing a varus thrust gait. Injury to the posterolateral corner often occurs in conjunction with other ligament damage. Associated ligamentous injury is reported to range from 43% to 80%. The most common ligament injured in addition to posterolateral corner injuries are either an anterior cruciate or posterior cruciate ligament.

HISTORY

In 1980 Hughston wrote of the challenge of diagnosing posterolateral corner injuries. “Presentation of this instability may be subtle, and diagnosis requires a keen awareness and astute observation on the part of the examiner and the meticulous performance of specific tests for knee stability. The examiner requires all information as to the mechanism of injury, symptoms, and physical examination to establish a diagnosis.”

Posterolateral corner injuries occur with trauma in sports, motor vehicle accidents, and falls as the most common causes. Chen reported that 40% of posterolateral corner injuries occurred as a result of sports injuries. A blow to the anteromedial knee, hyperextension, or varus forces cause most posterolateral corner injuries. A typical example would be seen in a wrestler with a foot fixed to the mat who sustains a blow to his anteromedial tibia when his opponent drives forward and forces his knee posterior and lateral into hyperextension.

Patients may complain of pain in the posterolateral aspect of the knee. Patients with chronic instability often report limitation of activity secondary to instability. They may report difficulty with running because of a varus thrust gait or report the knee giving-way during knee extension maneuvers like climbing stairs. Pivoting
maneuvers may also produce symptoms of instability when the lateral tibial plateau excessively externally rotates.\textsuperscript{1,3} It is important to also rule out injury to the common peroneal nerve. The patient should be questioned regarding initial or intermittent sensory or motor deficits of the ankle or hallux.\textsuperscript{11}

**THE PHYSICAL EXAMINATION**

The physical examination of the knee should follow a routine, systematic approach. Alignment and gait are assessed initially if possible. With an acute injury an antalgic gait pattern may be noted. In the setting of chronic posterolateral insufficiency the patient may stand in asymmetric, pathologic varus alignment. With ambulation a dynamic varus thrust gait where the lateral compartment of the knee books open with heel strike may be noted.\textsuperscript{11} Patients may learn to avoid the uncomfortable heel strike and use a knee-flexed gait instead.\textsuperscript{2,4,11} In the acute setting the examiner should look for evidence of trauma. Knee swelling and ecchymosis should be noted. Abrasions or contusions may be apparent on the anteromedial tibia. Although an LCL and posterolateral corner injury may cause an effusion, a large effusion would lead the clinician to search for concomitant intraarticular pathology. Next, range of motion should be assessed and compared with the contralateral leg. Asymmetric hyperextension would suggest posterolateral corner injuries. The neurovascular status should be also carefully examined. Laprade reported a 12.7\% incidence of common peroneal nerve injury with posterolateral corner injuries. Most of these patients had combined motor and sensory deficits.\textsuperscript{9} Intact sensation along the dorsum of the foot and first web space should be documented as well as the strength of hallux, ankle dorsiflexion, and ankle eversion to evaluate the common peroneal nerve. Dorsalis pedis and posterior tibial pulses should also be palpated and documented, especially in the setting of multiple ligament damage or when surgical intervention is contemplated. The possibility of a knee dislocation should be raised in the setting of multiple ligament injury to the knee.\textsuperscript{4,18} Finally, the integrity of the extensor mechanism should be confirmed and ligamentous testing should follow. Cruciate and collateral ligament integrity should be assessed. Several clinical tests exist to test for the posterolateral corner.

**EXTERNAL ROTATION RECURVATUM TEST**

This test was described by Hughston and Norwood in 1980.\textsuperscript{2} With the patient supine, the examiner holds onto both of the patient’s great toes and lifts their heels off of the examination table at the same time (Fig. 1).\textsuperscript{2} A patient with significant posterolateral corner injury will hyperextend the affected leg compared with a normal knee. There is often an associated external rotation of the knee and tibia vara. Hughston believed the examiner should look at the tibial tuberosities, while performing the test to watch for the associated tibial external rotation.\textsuperscript{2} He also described an alternative method to perform the test by holding the heel of the patient with one hand and gently holding the posterolateral aspect of the knee in 30° flexion with the other hand. As the leg is brought into extension from 30° of flexion, the examiner can feel the relative hyperextension and external rotation.\textsuperscript{2} The test is positive with significant posterolateral corner injury and cruciate ligament damage.\textsuperscript{11,24}

**POSTEROLATERAL DRAWER TEST**

This test primarily assesses rotational stability.\textsuperscript{2} Hughston and Norwood described this test in addition to the external rotation recurvatum test in 1980.\textsuperscript{2} The posterolateral drawer test is performed with the knee in flexion, whereas the external rotation recurvatum test assesses the knee in extension. A positive posterolateral drawer test usually indicates a popliteal tendon or popliteofibular ligament injury.\textsuperscript{24} The patient’s knee is flexed to 90° while the foot is placed in 15° external

---

**FIGURE 1.** External recurvatum test. The great toes are held by the examiner as both legs are raised simultaneously. A positive test results in hyperextension, external rotation of the tibia, and apparent tibia vara of the affected limb. Reprinted with permission from Hughston et al.\textsuperscript{2}
rotation (Fig. 2). It is helpful for the examiner to stabilize the patient’s foot with the examiner’s thigh. A posterior force is applied to the proximal tibia. A significant increase in posterior translation compared with the contralateral knee denotes a posterolateral corner injury. Reprinted with permission from Hughston et al.2

**VARUS STRESS TESTING**

The lateral collateral ligament (LCL) is predominantly assessed with varus stress testing performed in full extension and in 30° of flexion. The distal femur is stabilized with one hand while a finger or thumb is placed along the lateral joint line.24 The other hand is used to apply gentle varus force at the lower leg or ankle. The amount of lateral joint line opening is then quantified.

**FIGURE 2.** Posterolateral drawer test. The foot is placed in 15° external rotation. A posteriorly directed force is applied to the proximal tibia. A significant increase in posterior translation compared with the contralateral knee denotes a posterolateral corner injury. Reprinted with permission from Hughston et al.2

**FIGURE 3.** Reverse pivot shift. The knee is placed in 70° to 80° of knee flexion. The knee is extended with a valgus force. Reduction will be noted at 20° of knee flexion as the iliotibial band changes its direction of force. It can be positive in normal patients. Reprinted with permission from Jakob et al.26
The other leg should be used for comparison. Significant varus laxity at 0° suggests a cruciate ligament tear in addition to LCL injury. The anterior and posterior cruciate ligaments serve as secondary varus stabilizers in full extension. At 30° the varus stress test is more specific for lateral collateral injury. The amount of lateral opening may be graded in millimeters when compared with the opposite normal knee. A grade 1 injury opens 0–5 mm. A grade 2 injury opens up 6–10 mm, and a grade 3 injury opens > 10 mm. A grade 3 injury at 0° indicates cruciate and LCL damage, whereas a grade 3 injury at 30° indicates complete tear of the LCL.

**REVERSE PIVOT SHIFT TEST**

This test is a dynamic form of the posterolateral drawer test. It was first described by Jakob in 1981. The knee is placed into 70° to 80° of flexion, and the foot is externally rotated. With a positive test, the knee is subluxed in flexion, and a posterior sag of the proximal tibia may be noted (Fig. 3). The leg is slowly brought into full extension as a valgus force is applied. As the iliotibial band changes its force vector, the knee is felt to reduce at about 20° of flexion. A positive reverse pivot shift may also be noted in some normal knees. Cooper studied 100 asymptomatic patients undergoing unrelated surgeries. He performed an examination under anesthesia and found that 35 patients had a positive reverse pivot shift. Therefore, comparison to the contralateral normal knee is necessary.

**DIAL TEST OR POSTEROLATERAL ROTATION TEST**

This test is performed with the knee flexed at 30° and 90°. The patient may be supine or prone. In the supine position the legs may either be supported on a thigh support or allowed to hang off the end of the examining table. The thighs are stabilized by an assistant or a strap, while the lower legs are synchronously externally rotated. The amount of external rotation at the tibial tuberosity is compared with the other side. If prone, the external rotation may be measured by the thigh-foot angle. An increase of 10° to 15° is considered a positive test and suggests a significant posterolateral corner injury (Fig. 4). An isolated posterolateral corner injury will result in less external rotation at 90° compared with 30°. If there is increased external rotation at 90° as well, then a combined posterior cruciate and posterolateral corner injury is present.

**RADIOGRAPHS**

Plain radiographs are usually normal in patients with posterolateral corner injuries but may occasionally exhibit bony abnormalities. These include a Segond fracture, a medial Segond fracture, an arcuate sign or...
fibular styloid fracture, avulsion of Gerdy tubercle or abnormal widening of the lateral joint space.\(^3\)

In addition to the standard knee radiograph series, stress radiography may prove helpful in diagnosing lateral injuries. A gentle varus force applied to the knee may demonstrate widening of the lateral compartment (Fig. 5).

Although well known in association with anterior cruciate ligament injuries, Segond fractures or avulsion fractures of the lateral capsule can be seen with isolated posterolateral corner injuries.\(^3\) The midlateral capsule is stout and may cause an avulsion fracture at its attachment point when the knee sustains pathologic forces.\(^3\) These fractures appear as a fleck of bone on the anterolateral tibia.

A medial Segond fracture may also be seen in association with posterolateral corner injuries (Fig. 6).\(^28,29\) It is an uncommon radiographic finding and appears to occur with PCL tears or combined PCL and posterolateral corner injuries.\(^28-31\) In 1997 Hall and Hochman described a small anteromedial tibial plateau fracture in association with a posterior cruciate ligament injury.\(^30\) They hypothesized the fracture occurred as an avulsion injury with a flexed knee undergoing valgus and external rotation forces and called it a medial Segond fracture. Cohen et al\(^{28}\) described a similar finding in 2001 in association with PCL and posterolateral corner injuries. However, they believed the fracture resulted from impingement of the anterior medial femoral condyle on the anteromedial tibial plateau as the hyperextended knee was brought into varus. Cohen et al hypothesized that only significant injuries or high-grade PCL tears would allow the posterior tibial translation for the impaction fracture. Evidence of the impingement was noted with bone bruising on the anterior aspect of the medial femoral condyle on MRI. Bennett et al reported on a series of 16 patients with posterolateral corner injuries exhibiting this fracture. Five out of 16 knees possessed a medial Segond fracture, and all these patients sustained cruciate damage.\(^29\) They felt it occurred as an avulsion injury of the medial capsule from an anteromedial blow to a flexed knee or from a hyperextension injury.\(^29\) They recommended that its presence should prompt a careful search for posterolateral corner injuries.

A fibular styloid fracture also known as an arcuate sign is a pathognomonic sign for posterolateral corner injury (Fig. 7).\(^32-35\) The popliteofibular, fabellofibular, and arcuate ligaments are often referred to as the arcuate complex and insert on the fibular styloid of the fibular head.\(^34\) The fragment is often small (1–8 mm) and displaced immediately medially and superiorly.\(^33\) The arcuate sign may not always be visible on lateral radiographs because of superimposition.\(^34\) It is better visualized with the lateral radiograph in slight external rotation.\(^34\)

The fibular styloid fracture should not be confused with a fibular head fracture or an avulsion fracture of the LCL (Fig. 8). The LCL and biceps femoris tendon insert as the conjoined tendon on the lateral aspect of the fibular head, anteriorly and inferiorly to the styloid process. A conjoined tendon avulsion fracture or fibular head

---

**FIGURE 6.** Medial Segond fracture (denoted by arrow) on AP radiograph. An uncommon finding that may indicate posterolateral corner injury. Reprinted with permission from Hall et al.\(^{26}\)

**FIGURE 7.** Arcuate sign or fibular styloid fracture on lateral radiograph (A) with comparative diagram (B). The arcuate sign is pathognomonic of posterolateral corner injuries. It is an avulsion fracture of the arcuate complex. The fracture (denoted by arrow) is small and posteriorly located with minimal displacement. Circles denote the insertions of the arcuate complex. Reprinted and modified with permission from Laprade et al.\(^5\)
fracture fragment tends to be larger (1.5–2.5 cm) and distally located with greater displacement proximally than an arcuate fracture.33

MAGNET RESONANCE IMAGING

Magnetic resonance imaging (MRI) is the primary tool for assessing soft tissue injuries to the posterolateral corner. The normal LCL appears as a taut black structure on T1 and T2 weighted sequences and is best visualized on coronal images. The degree of edema and the determination of fiber continuity on T2 weighted sequences helps define the structural integrity of the LCL (Fig. 9). Grade 1 sprains exhibit edema or a high T2 signal superficial to the ligament fibers, but the ligament is intact. Grade 2 sprains exhibit edema through the ligament, but some fibers remain intact. Grade 3 injuries reveal complete disruption of the ligament with deep and superficial edema. There are no intact fibers.36,37

However, traditional MR imaging has some limitations with regard to the other structures of the posterolateral corner. The natural variability of the posterolateral corner anatomy along with the finer dimensions and oblique orientation of travel of its components make identification difficult (Fig. 10). MR imaging of the arcuate ligament, fabellofibular ligament, and popliteofibular ligament are more difficult than the biceps and LCL.38,39 Laprade recommends the use of a high strength magnet (1.5 T or higher) and the addition of a thin cut proton density coronal oblique series to help image the posterolateral corner.11 Yu reports the ability to visualize the fabellofibular, arcuate, and popliteofibular ligament to be 10%, 34%, and 8% on traditional sequences respectively. With the addition of the coronal oblique series, the ability to identify the various ligaments increases to 48%, 46%, and 53% respectively.40 A coronal oblique series is recommended to help image the fine detail of the posterolateral corner.11,40
Injuries of the posterolateral corner can occur in a large variety of patterns. In addition to the traditional components of the posterolateral corner, other adjacent structures may be injured; this may include a popliteus tendon tear noted by edema on MRI (Fig. 11). \(^{35}\) Injury to the lateral head of the gastrocnemius or to the biceps may also be involved. \(^{35}\)

**CONCLUSION**

Isolated injuries of the posterolateral corner are uncommon and cause significant disability especially when they occur in conjunction with other ligament pathology. Timely diagnosis is important for allowing acute repair and ensuring successful cruciate reconstruction when necessary. Chronic injury can result in abnormal dynamic alignment and gait patterns with significant functional disability. The diagnosis of posterolateral corner injuries can be challenging because it relies on a culmination of historical, physical, and radiographic findings with a high level of suspicion.

Recognition of injury mechanisms will aid the examiner in suspecting posterolateral corner injuries. A systematic knee examination in conjunction with specialized clinical tests will help in identification. Veltri and Warren found the prone dial test and the varus stress test the most useful for clinical diagnosis. They used the other tests for additional confirmatory information. \(^{3,4}\) However, increased external rotation may not always be obvious, especially in the acute setting.

Uncommon but characteristic radiographic findings may help the clinician in diagnosing posterolateral corner injuries. Varus stress radiography may demonstrate abnormal lateral compartment widening. Failure of different soft tissue structures can be inferred from fibular styloid or fibular head avulsion fractures seen on plain radiographs. Identification of the Segond or medial Segond lesion suggests cruciate and possible posterolateral pathology. MRI is also helpful but again is not particularly sensitive, especially in the community setting. A coronal oblique series, high magnet strength, and experienced radiologists aid in diagnosis.

**REFERENCES**


