

Posterolateral corner injury

Anatomy & Pathophysiology

BONY ANATOMY

- The bones of the knee are the distal femur, the proximal tibia, and the patella [1].
- The medial femoral condyle is larger and projects farther posteriorly and distally than the lateral condyle [6].
- The lateral femoral condyle projects farther anteriorly and is wider in the medial-lateral direction than the medial femoral condyle [6].
- The sulcus terminalis is a small ridge on the lateral femoral condyle just distal to the intercondylar notch that separates the patellofemoral and tibiofemoral articular surfaces [6].
- The tibial articular surface slopes 7° to 10° in the sagittal plane [6].
- The medial tibial plateau is larger than the lateral plateau and is concave in its frontal and sagittal planes [6].
- The lateral tibial plateau is smaller and more circular than the medial plateau, concave in the frontal plane and convex in the sagittal plane [6].
- The proximal fibula articulates with a facet of the lateral cortex of the tibia and is not part of the knee articulation [6].
- The Gerdy's tubercle is the insertion site of the iliotibial band and is located 2 to 3 cm lateral to the tibial tubercle on the proximal tibia [6].
- The fibular head is located a mean of 1.5 cm distal to the joint line, with a range of 6 to 32 mm [18].

LIGAMENTS

- The lateral collateral ligament (LCL) runs from the lateral femoral condyle to the head of the fibula and is the main stabilizer against varus stress [1].
- The LCL is part of the posterolateral "complex" or "corner" of the knee that also resists external rotation [1].
- The popliteofibular ligament is present in 90% of knees and runs from the tendon of the popliteus muscle to the styloid on the posterior fibular head [1].

- The LCL resists varus tibial translation as its primary function and tibial external rotation, especially at 30 degrees of knee flexion, as its secondary function [7].
- The popliteus tendon resists tibial external rotation, especially in knee flexion, as its primary function and varus tibial translation as its secondary function [7].
- The popliteofibular ligament resists tibial external rotation, especially in knee flexion, as its primary function and posterior tibial displacement as its secondary function [7].
- The oblique popliteal ligament resists knee hyperextension as its primary function and varus tibial translation as its secondary function [7].
- The posterolateral corner (PLC) is made up of the FCL, the iliotibial band, the popliteofibular ligament, the biceps femoris, and the popliteus tendon [24].
- The PLC resists posterior translation, external rotation, and varus angulation of the tibia [24].
- The popliteus tendon originates on the posterocentral tibia and inserts anterior and distal to the LCL on the lateral femoral epicondyle [18].
- The popliteus tendon has an intra-articular course through the popliteal hiatus [18].

MENISCI

- The menisci are C-shaped fibrocartilaginous disks that provide shock absorption, increase congruency between joint surfaces, enhance joint stability, and aid in distribution of synovial fluid [1].
- The medial meniscus is firmly attached to the joint capsule along its entire peripheral edge [1].
- The lateral meniscus is attached to the anterior and posterior capsule, but there is a region posterolaterally where it is not firmly attached [1].
- The lateral meniscus is larger than the medial meniscus and carries a greater share of the lateral compartment pressure than the medial meniscus carries for the medial compartment [1].
- The lateral meniscus has a more circular C-shape with symmetric sizes of the anterior and posterior horns [15].
- The popliteomeniscal fascicles extend from the lateral meniscus to the posterior capsule to create the popliteal hiatus [15].
- The less continuous attachment of the lateral meniscus to the capsule allows for greater meniscal mobility [15].
- Mean lateral meniscus excursion from knee extension to flexion is 11.2 mm, compared to a mean medial meniscus excursion of 5.1 mm [15].
- The lateral meniscus covers a larger proportion of the tibial plateau than the medial meniscus [18].
- The lateral meniscus has a mobility of 10 mm, while the medial meniscus has a mobility of 5 mm [18].

VASCULAR AND NERVE ANATOMY

- The blood supply to the knee is formed from an anastomosis around the knee derived from the descending geniculate artery, medial and lateral superior geniculate arteries, medial and lateral inferior geniculate arteries, middle geniculate artery, and anterior tibial recurrent arteries [6].

- The inferior geniculate arteries pass deep to their respective collateral ligaments [6].
- The knee is innervated by branches of the femoral nerve (L2, L3, L4), obturator nerve (L2, L3, L4), and sciatic nerve (L4, L5, S1, S2) [6].
- The largest nerve providing innervation of the intra-articular knee is the posterior articular branch of the tibial nerve [6].
- The popliteus artery travels through the adductor hiatus, where it is relatively immobile, and distally through the fibrous arch deep to the soleus muscle [24].
- The common peroneal nerve travels along the posterior edge of the biceps femoris and continues distally around the fibular neck [24].
- The tibial nerve courses distally through the center of the popliteus fossa after branching from the sciatic nerve [24].

PATHOPHYSIOLOGY AND BIOMECHANICS

- If the menisci are not present, the convex femoral condyles articulate with the relatively flat tibial plateaus, decreasing surface area of contact and increasing pressure on the articular cartilage [1].
- The medial meniscus has less mobility than the lateral meniscus and is more susceptible to tearing when trapped between the femoral condyle and tibial plateau [1].
- Biomechanical studies show a significantly higher graft force during varus loading at 0 and 30 degrees of knee flexion after transection of the LCL than with intact posterolateral structures [5].
- In knees with grade III posterolateral injuries and evidence of varus or coupled posterior-external rotation instability, repair or reconstruction of the posterolateral structures should be performed at the time of PCL reconstruction to decrease the chance of later graft failure [5].
- The menisci bear one-third to one-half body weight and help with load transmission [19].
- Removal of the menisci increases contact stresses, with up to four times the load transfer to bone [19].

Investigations

PHYSICAL EXAMINATION

- A thorough knee examination should be performed to evaluate for coexisting knee pathology in patients with LCL and/or posterolateral corner injury [31].
- A careful neurovascular examination should be performed because the incidence of neurovascular injury, particularly peroneal nerve injury, has been reported in 12–29% of posterolateral knee injuries [31].
- The integrity of the LCL is assessed by placing a varus stress with the knee in full extension and 30 degrees of flexion [31].
- Baseline varus opening is widely variable and should be compared to the contralateral leg [31].
- The average baseline for varus opening is 7 degrees [31].

- Exam findings with an isolated LCL injury include varus laxity at 30 degrees of flexion and no instability in full extension [31].
- A significant posterolateral knee injury can be present without significant varus laxity [31].
- The dial test is the most useful test to evaluate for posterolateral instability [31].
- The dial test is performed by externally rotating each tibia and noting the angle subtended between the thigh and the foot at 30 and 90 degrees of flexion [31].
- A significant difference in the dial test is an angle 5 degrees or greater than the contralateral leg [31].
- Greater external rotation at 30 degrees on the dial test confirms injury to the posterolateral capsule alone [31].
- Greater external rotation at 90 degrees on the dial test confirms an isolated PCL injury [31].
- Greater rotation at both 30 and 90 degrees compared to the uninjured leg on the dial test confirms injury to both posterolateral capsule and PCL structures [31].
- The reverse pivot shift test involves starting with the knee flexed to 90 degrees, extending the knee while applying axial load and valgus stress, and holding the foot in external rotation [31].
- A palpable shift is noted during the reverse pivot shift test as the tibia reduces from its posteriorly subluxed position as the knee is extended [31].
- The external rotation recurvatum test is performed with the patient supine and the hip and knee fully extended [31].
- In the external rotation recurvatum test, the leg is lifted off the bed by the toes [31].
- Hyperextension, varus instability, and external rotation of the tibial tubercle occur with adequate quadriceps relaxation in a patient with posterolateral instability during the external rotation recurvatum test [31].
- The posterolateral drawer test is performed with the tibia in internal rotation, neutral, and externally rotated positions [31].
- With posterolateral injury, the magnitude of the posterior drawer displacement is greatest with external tibial rotation [31].
- An examination under anesthesia is extremely useful, particularly in the acute setting [31].
- If a patient with a multiligamentous knee injury is taken to the operating room, examining the knee without guarding improves the accuracy of the examination [31].

IMAGING STUDIES

- A series of knee radiographs should be obtained in any patient with a suspected knee injury [31].
- Radiographs should be inspected for acute fractures, lateral capsular avulsion (Segond fracture), loose bodies, fibular head avulsions, and evidence of patellar dislocation [31].
- With chronic posterolateral instability, degenerative changes of the lateral compartment are often noted on radiographs [31].

- Lateral joint space narrowing with osteophytes and subchondral sclerosis can be seen on radiographs in chronic posterolateral instability [31].
- Stress radiographs can help to better quantify the amount of varus angulation present [31].
- MRI is often a useful adjunct for diagnosing posterolateral corner and LCL injuries in the severely injured knee [31].
- MRI findings can refocus the examination to the posterolateral structures when this injury has gone unnoticed during an initial evaluation [31].
- Pain and guarding at the time of injury can often obscure posterolateral injury, making MRI an extremely valuable adjunct in diagnosis [31].
- MRI should be obtained as a useful adjunct to help diagnose posterolateral corner injuries [31].
- MRI may identify edema, avulsion, or discontinuity for the MCL/lateral collateral ligament (LCL) or associated posteromedial and posterolateral ligamentous complexes [22].

NON-OPERATIVE MANAGEMENT

- Isolated grade I and II tears of the lateral collateral ligament (LCL) can be managed with nonsurgical treatment and early rehabilitation [5].
- Nonsurgical management of isolated grade III LCL injuries produced poor results in clinical studies by Krukaug et al. and Kannus [5].
- In a cohort of National Football League players, isolated grade III LCL injuries managed nonoperatively were as likely to return to play as those managed surgically and did so more quickly [5].
- Despite controversial results regarding nonoperative management of grade III LCL injuries in NFL players, the authors recommended surgical treatment for most grade III injuries [5].

OPERATIVE MANAGEMENT

- For acute lateral compartment disruptions, the knee is examined for instability classification and systematic grading after the patient has been anesthetized [5].
- Systematic arthroscopic examination is usually carried out to assess and rule out other intraarticular pathologic conditions before proceeding with repair or reconstruction of the posterolateral corner [5].
- Biomechanical studies have shown a significantly higher graft force during varus loading at 0 and 30 degrees of knee flexion after transection of the LCL than with intact posterolateral structures [5].
- Posteromedial corner injuries have been implicated in anteromedial rotary instability and failed ACL reconstructions [5].
- The anterolateral ligament (ALL) is not an isometric ligament; its length increases with knee flexion as well as internal rotation [5].
- The ALL usually originates on the femur, posterior and proximal to the lateral femoral epicondyle, although some have located it either directly on the lateral epicondyle or anterior and distal to the attachment site of the LCL [5].

- The tibial attachment site of the ALL resides halfway between the center of Gerdy's tubercle and the anterior margin of the fibular head and 1 cm distal to the joint line [5].
- The ALL has a mean ultimate load to failure between 50N and 205N, a mean stiffness of 20 to 42 N/mm, and a mean ultimate strain of 36% [5].
- Cadaver and biomechanical studies have shown the importance of the ALL as a restraint to internal tibial rotation and anterior tibial translation and in preventing the knee pivot shift phenomenon [5].
- Experimental sectioning of the ALL was found to invariably induce high-grade pivot shifts in ACL-deficient cadaver knees, unlike isolated ACL injury [5].
- There is no consensus regarding the proper angle of knee flexion at which fixation of ALL reconstruction should occur [5].
- Anatomic ALL reconstruction at all graft fixation angles significantly overconstrained internal rotation of the knee joint beyond 30 degrees of flexion and at 45 and 60 degrees during the pivot shift test [5].
- There were no significant kinematic differences between any tested graft fixation angles during anterior drawer, pivot shift, and internal rotation tests [5].
- Most authors report fixing the ALL reconstruction graft at 30 degrees of flexion to avoid overconstraint [5].
- Sonnery-Cottet et al. reported full range of motion in 83 patients at a minimum 2-year follow-up after combined reconstructions of the ACL and ALL [5].
- In the study by Sonnery-Cottet et al., 76 patients had a negative pivot shift and seven had a grade 1 pivot shift after combined ACL and ALL reconstruction [5].
- Sonnery-Cottet et al. reported significant improvements in Lysholm scores, subjective IKDC scores, and objective IKDC scores after combined ACL and ALL reconstruction [5].
- Sonnery-Cottet et al. found that ALL reconstruction protected the repaired medial meniscus [5].
- Indications for combined ACL and ALL reconstructions reported by Sonnery-Cottet et al. include an associated Segond fracture, a chronic ACL lesion, grade 3 pivot shift, high level of sports activity, participation in pivoting sports, and lateral femoral notch sign on radiographs [5].
- Other surgeons have included revision ACL reconstruction as an indication for ALL reconstruction [5].
- In a study of 552 patients who had primary ACL reconstruction, Gaunder et al. identified 47 patients who required revision ACL reconstruction [5].
- The incidence of Segond fractures was 6% in the primary ACL reconstruction group studied by Gaunder et al. [5].
- After ACL reconstruction, the Segond fracture healed in 90% of patients in the study by Gaunder et al. [5].
- No patient with revision surgery had a Segond fracture, and no patient with a Segond fracture had graft failure in the study by Gaunder et al. [5].

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