The Posterolateral Corner of the Knee

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OBJECTIVE. The purpose of this article is to review the clinical importance and MRI appearances of injuries to the posterolateral corner of the knee.

CONCLUSION. Injuries to the posterolateral corner structures of the knee can cause significant disability due to instability, cartilage degeneration, and cruciate graft failure. Becoming familiar with the anatomy of this region can improve one's ability to detect subtle abnormalities and can perhaps lead to improvements in diagnosing and understanding injuries to this area.

The use of MRI in the evaluation of knee trauma and instability has become a mainstay of clinical practice in great part because of its high accuracy in the identification of meniscal and ligamentous abnormalities. The increasing recognition of the importance of the diagnosis of posterolateral corner injuries—and the subsequent repair of such injuries—among our orthopedic surgery colleagues has driven those of us involved in imaging to attempt to detect these injuries preoperatively with MRI. This article reviews the clinical importance of posterolateral corner instability, including the often controversial management of these cases and the normal and abnormal appearances of the various structures of the posterolateral corner as visualized on MRI.

Posterolateral Corner Instability: Clinical Features and Management

Rotatory instability of the posterolateral corner of the knee is a complex and difficult clinical entity in terms of both diagnosis and treatment. The stability of the posterolateral corner of the knee is provided by capsular and noncapsular structures that function as static and dynamic stabilizers [1], including the fibular collateral ligament, the popliteus muscle and tendon including its fibular insertion (popliteofibular ligament), and the lateral and posterolateral capsule. Injuries to this region that result in posterolateral rotatory instability can be but are uncommonly isolated; usually these injuries are associated with concurrent ligamentous injuries elsewhere in the knee [2–5].

In particular, posterolateral corner injuries are frequently seen in combination with posterior cruciate ligament (PCL) injuries. In one study of 85 patients with acute PCL injuries, 53 (62%) were also diagnosed with posterolateral corner tears by clinical examination, arthroscopy, or MRI (or a combination thereof) [3]. Given this significant association, when MRI reveals evidence of an acute PCL injury, particular attention should also be paid to the posterolateral structures of the knee.

The mechanism of injury is thought to be either a direct blow to the anteromedial proximal tibia, directed posterolaterally, with the knee near full extension [6], which is thought to be most common, or a noncontact, external rotation hyperextension injury [1]. This area is also often injured in complete knee dislocations, resulting from a combination of varus force with hyperextension (in an anterior rotatory dislocation) or a combination of varus force with a posteriorly directed blow to the proximal tibia with the knee flexed ("dashboard injury," in a posterior rotatory dislocation) [4, 7]. A high degree of suspicion is necessary to make the diagnosis of posterolateral corner instability, and failure to recognize these often elusive injuries can have consequences of chronic instability, a predisposition to cruciate graft failure, or both as discussed later in this article.

When posterolateral corner injury is suspected, testing for increased varus and external rotation should be performed at various

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degrees of flexion and compared with the contralateral knee [8]. The dial test, or posterolateral rotation test, which assesses for increased external rotation of the tibia relative to the femur with the knee flexed to 30°, is one of the standard tests to assess and follow posterolateral rotatory instability [9].

High-grade posterolateral corner injuries are usually associated with rupture of one or both cruciate ligaments. Importantly, failure to address instability of the posterolateral corner structures increases forces at anterior cruciate ligament (ACL) and PCL graft sites and may ultimately predispose to failure of the cruciate reconstruction [10–12]. Untreated posterolateral corner injuries contribute to ACL graft failure by allowing significantly higher forces to stress the graft with varus loading at varying degrees of flexion than occurs with intact posterolateral corner structures [12].

Unrecognized and untreated posterolateral corner instability is possibly the most common identifiable cause of ACL reconstruction failure [2, 13]. Likewise, biomechanical studies of PCL grafts have shown that PCL reconstruction grafts are rendered ineffective and may become overloaded in the setting of deficiency of the posterolateral corner structures due to increases in the in situ forces in the graft during loading [11]. In addition, better functional outcomes are achieved with repair of the PCL and the posterolateral corner structures than with repair of the PCL alone [14]. Given the relatively high incidence of concomitant injuries to the posterolateral structures in the setting of ACL and PCL injuries, unrecognized posterolateral corner injuries are a major cause of eventual graft failure when only the cruciate injury is recognized and addressed [11, 12].

Regardless of the status of the cruciate ligaments, failure to address high-grade posterolateral instability may lead to the development of significant osteoarthritis. One study evaluating the outcomes of nonoperative treatment for grade II and grade III lateral ligament sprains in patients without clinical evidence of complete tears of either cruciate ligament found a high incidence—50%—of posttraumatic osteoarthritis in the patients with grade III sprains at 8-year follow-up. The patients with grade II sprains responded well to nonoperative treatment; although residual laxity remained present at follow-up, no patients in this group suffered from posttraumatic osteoarthritis. The authors postulated that with grade III injuries, the degree of ligamentous laxity and static instability was too great to be compensated for by the dynamic stabilizing function of the knee muscles and tendons [15].

Because of the potential debilitating consequences of an unrecognized injury to the posterolateral corner structures, attention with regard to the diagnosis and management of these injuries has increased. However, there has been much debate in the orthopedics literature regarding the optimal methods of management of posterolateral corner injuries. Injuries to the posterolateral ligamentous structures are often classified as grade I, II, or III sprains, corresponding to minimal, partial, or complete tearing, respectively. Grade III injuries are usually associated with markedly abnormal joint motion and are the most clinically relevant from a surgical standpoint.

Clinically, a numeric scale is often qualitatively used to describe the degree of ligamentous instability as 1+ (mild), 2+ (moderate), or 3+ (severe). A similar quantitative scale, depicting the degree of abnormal joint opening with stress on clinical examination, is also used, with 3+ describing an opening of > 10 mm with a soft or no appreciable end point [8]. Patients with evidence of injury but without significant pathologic laxity or functional limitations, corresponding to grade I and II injuries, are often treated with rehabilitation and observation [5]. In patients with laxity, corresponding to grade III injuries, most authors advocate either repair or reconstruction of the posterolateral corner in the setting of acute or chronic posterolateral instability [8].

There is little clinical data regarding the long-term outcomes of surgical treatment of posterolateral corner injuries, and there is no agreement about the best surgical technique to use [16]. In general, operative procedures can be categorized as primary repair, reconstruction, and advancement [5, 8]. Operative treatment in the acute setting is thought to have a greater chance of successful outcome than surgery for chronic injuries [6, 8]. In particular, direct primary anatomic repair of the injured structures is most easily accomplished within 3 weeks of the inciting injury and when the tissues are of good quality [5, 8]. Evaluation and treatment proceed from deep to superficial structures, with repair of each torn structure by sutures, suture anchors, or sutures via drill holes through bone [1, 8].

Reconstruction of the posterolateral structures is usually performed in the acute setting when the quality of the tissues does not allow primary repair or in symptomatic patients with chronic posterolateral rotatory instability [2]. Many authors favor reconstruction over primary repair even in the acute setting because of improved outcomes, and some think that primary repair of the fibular collateral ligament is indicated only in patients with bone avulsions amenable to internal fixation [17, 18].

Reconstruction techniques vary widely. Numerous reconstruction techniques have been described in the medical literature, using a variety of allografts and autografts (often from patellar, Achilles, hamstring, biceps femoris, and tibialis tendon donor sites) to reinforce or replace the fibular collateral ligament, posterolateral capsule, popliteus tendon, or popliteofibular ligament with either anatomic or nonanatomic anchor sites [2, 8, 16–21]. In the setting of less severe chronic injury, if the posterolateral structures are lax but identifiable and have sufficient intact collagenous tissue, proximal advancement of the posterolateral complex may be performed to remove slackness and restore stability instead of the more complex graft reconstruction. In this procedure, the proximal attachments of the posterolateral complex, including the fibular collateral ligament and popliteus tendon, are excised from the femur and the complex is advanced proximally and reattached to the femur [19]. Some patients with varus alignment due to chronic posterolateral instability require proximal valgus tibial osteotomy before addressing the ligamentous abnormalities [21]. Further long-term clinical outcomes studies are necessary to determine the efficacy of the variety of procedures currently performed to restore posterolateral stability. Regardless of the surgical technique used, when necessary, concomitant cruciate ligament reconstruction should be performed before or during the posterolateral corner repair or reconstruction [2], although some authors prefer a two-stage procedure in cases of bicruciate injuries, with the PCL and posterolateral corner reconstructions performed before the ACL reconstruction [16].

Because MRI is commonly performed in the setting of knee injury, radiologists familiar with the normal and abnormal appearances of the posterolateral corner structures on MRI can suggest the diagnosis of posterolateral corner injury when present, leading to improvements in treatment and functional outcomes for patients in whom the injury was not clinically suspected—in particular, in those patients with concomitant ACL or PCL injuries requiring reconstruction. As we discussed earlier, the most surgically relevant of these injuries are thought to be the grade III injuries, roughly corresponding to those patients with 3+ ligamentous laxity [8].

Although there are no precise criteria for the MRI findings required to diagnose clinically relevant posterolateral instability, or grade III injuries, visualization of complete tears involving two or more structures of the posterolateral corner on MRI—in particular, the popliteus musculotendinous unit, the fibular collateral ligament, or the posterior lateral joint capsule—should strongly suggest posterolateral corner injury, especially in the setting of cruciate ligament tears, and should prompt close clinical evaluation for posterolateral rotatory instability.

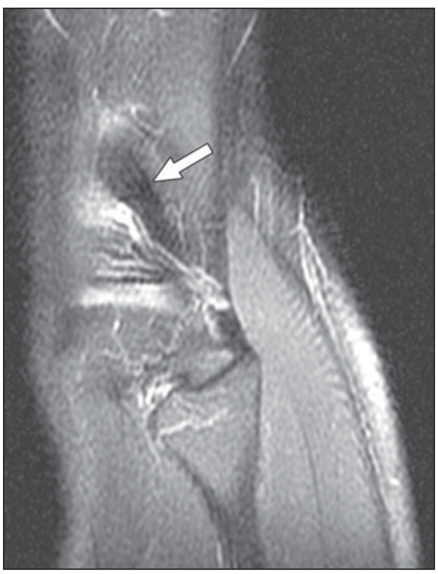


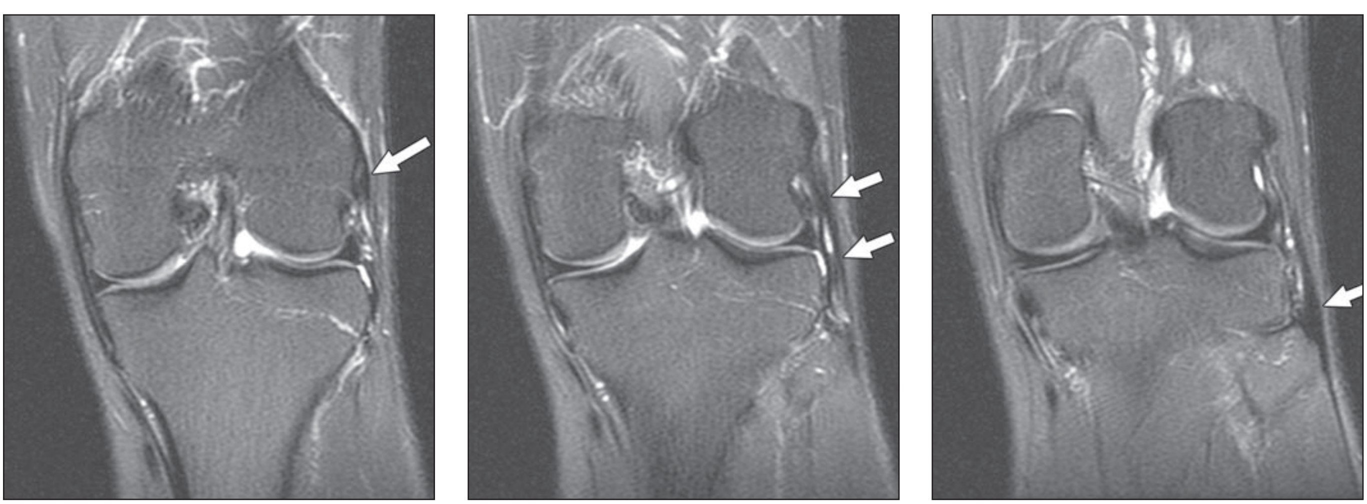
Fig. 1—Normal fibular collateral ligament in 21-year-old woman. Sagittal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 4,000/49) shows normal appearance of fibular collateral ligament (*arrow*).

Other imaging signs described to occur with posterolateral corner injuries include fractures of the fibular styloid process and anterior medial tibial plateau, contusions of the anterior medial femoral condyle, and lack of significant joint effusion [22, 23]. Available data suggest that injury or partial tear involving only one of these structures, even in the setting of cruciate ligament tear, is not sufficient to diagnose 3+ posterolateral rotatory instability [22]. Given that there is evidence that surgery—in particular primary anatomic repair—is more successful when performed within 1–4 weeks of the inciting injury [8, 18, 23], it is important to perform knee MRI on an urgent basis in patients suspected of having acute posterolateral corner injury and to notify the orthopedic surgeon as soon as possible when this diagnosis is suspected.

Posterolateral Corner Anatomy on MRI: Normal and Abnormal

There is great variability of the posterolateral aspect of the knee with regard to both the individual structures present and their contributions to the stability of the joint [24]. In general terms, three layers of structures comprise the lateral aspect of the knee, not all of which are visible on MRI. The superficial layer consists of the iliotibial band and the biceps femoris tendon. The middle layer consists of the quadriceps retinaculum, patellofemoral ligaments, and patellomeniscal ligament. The deepest layer consists of the lateral joint capsule along with its attachment to the edge of the lateral meniscus, the coronary ligament, and the fibular collateral ligament, which is encompassed by the capsule. The fabellofibular and arcuate ligaments, which are variable in terms of size and contributions to stability, are also encompassed by the capsule in this layer [24]. In addition to these structures, some authors describe a "deep" complex consisting of the popliteal muscle–tendon unit, including the popliteofibular ligament, the arcuate ligament, and the posterolateral joint capsule [25, 26].

Specific components of the posterolateral corner that can be identified on MRI, albeit with some variability, are the biceps femoris tendon, the fibular collateral ligament, the popliteus musculotendinous complex including the popliteofibular ligament, the fabellofibular ligament, and the arcuate ligament. In general, these normally low-signal-intensity structures are defined as injured or sprained when there is thickening and intermediate signal intensity within the structure on fat-suppressed fast spin-echo T2-weighted images and as torn when the structure is discontinuous with a visible gap. Some researchers support the use of a coronal oblique plane of imaging to improve visualization of some of the finer, obliquely oriented structures of the posterolateral corner, including the popliteofibular, arcuate, and fabellofibular ligaments [27], although this has not become routine. Recognition of bone marrow changes in the



A **B** **C**

Fig. 2—Normal fibular collateral ligament in 21-year-old woman.
A–C, Consecutive coronal fat-suppressed fast spin-echo T2-weighted images (TR/TE, 4,000/49) show normal appearance of fibular collateral ligament (*arrows*).

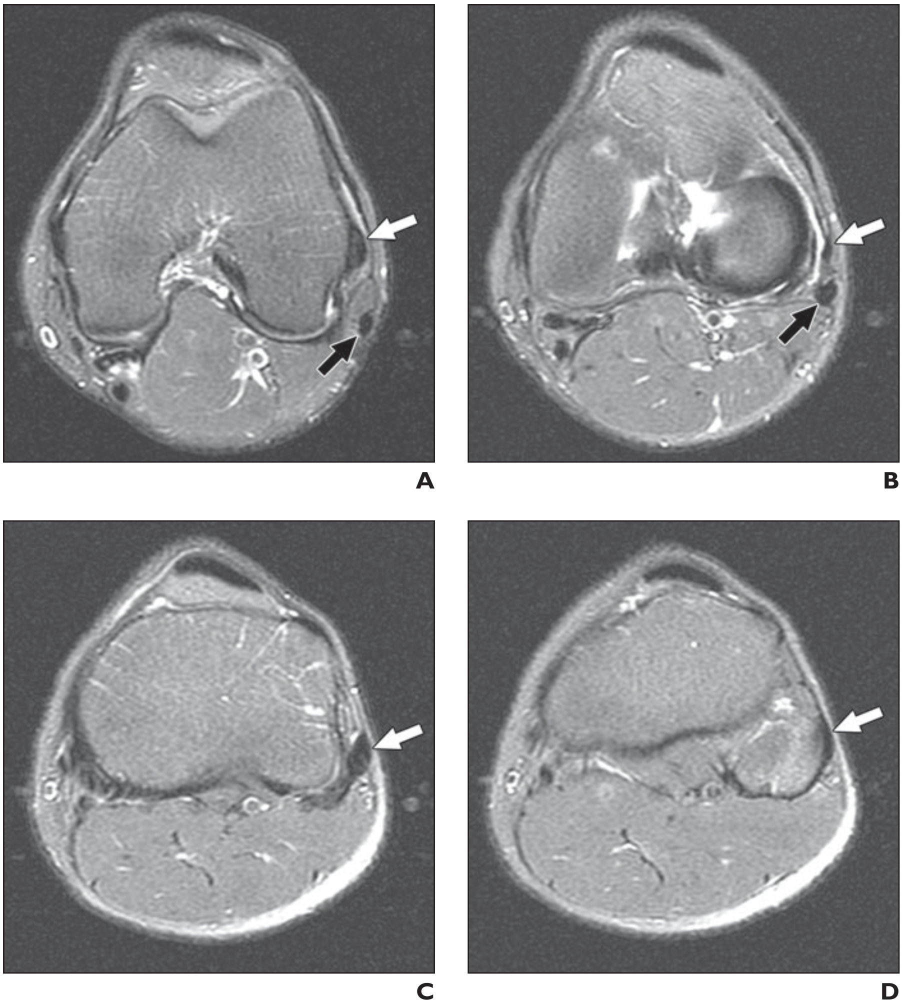


Fig. 3—Normal fibular collateral ligament in 21-year-old woman.
A–D, Consecutive axial fat-suppressed fast spin-echo T2-weighted images (TR/TE, 4,000/49) show normal appearance of fibular collateral ligament (*white arrows*, **A** and **B**). Distally, fibular collateral ligament often joins with biceps femoris tendon (*black arrows*, **A** and **B**) to form conjoined structure that inserts on lateral aspect of fibular head (*white arrows*, **C** and **D**).

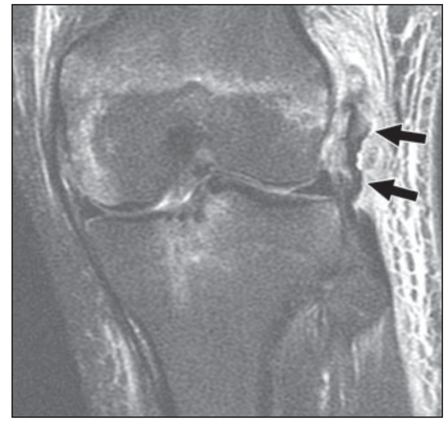


Fig. 4—Proximal tear of fibular collateral ligament in 20-year-old man. Coronal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 3,217/73) depicts proximal avulsion of fibular collateral ligament (*arrows*) from its femoral origin.

Fig. 5—Normal biceps femoris tendon insertion in 19-year-old woman. Coronal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 3,500/50) shows normal appearance of distal biceps femoris tendon (*arrows*).

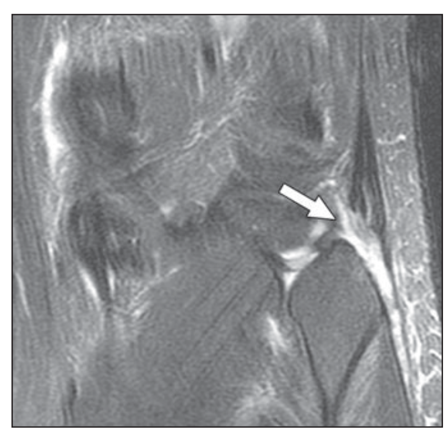


Fig. 6—Biceps femoris tendon with tear at insertion in 30-year-old man. Coronal fat-suppressed T2-weighted image (TR/TE, 4,000/70) shows avulsion of distal biceps femoris tendon from fibular head (*arrow*).

fibular head, including the so-called "arcuate" fracture that may also be seen on radiographs is also helpful in diagnosing posterolateral corner injury. Although posterolateral corner injuries are usually associated with accompanying injuries to one or both cruciate ligaments, the normal and abnormal appearances of the ACL and PCL are not reviewed here.

The Fibular Collateral Ligament and Biceps Femoris Tendon

The fibular collateral, or true lateral collateral, ligament originates from a small bone depression just posterior to the lateral femoral epicondyle and just anterior to the femoral attachment of the lateral head of the gastrocnemius tendon and extends distally and posteriorly over an oblique course to insert on the lateral aspect of the fibular head, anterior and distal to the tip of the fibular styloid process [28–30]. It is visualized on axial, sagittal, and coronal imaging planes as a low-signal-intensity structure extending from the lateral aspect of the distal femur to the proximal fibula (Figs. 1–3). Just before its insertion, the fibular collateral ligament often joins the distal biceps femoris tendon to form a conjoined structure [31–33].

Fibular collateral ligament abnormalities are commonly seen in posterolateral corner injuries and are well depicted by MRI [28, 34]. Injuries to the fibular collateral ligament are best visualized on coronal and axial T2-weighted images and include soft-tissue avulsion off the femoral attachment (Fig. 4), periligamentous edema, complete or partial-thickness intrasubstance tears, and soft-tissue or bone avulsion from the fibular head [28, 31, 34, 35].

The long and short heads of the biceps femoris tendon typically join above the knee and course distally to insert predominantly onto the fibular head. Although both the long and short heads of the biceps femoris tendon have multiple tendinous and fascial components, not all of these components are consistently visible as separate structures on MRI [32, 36]. The direct and anterior tendinous arms of the long head of the biceps femoris attach to the anterior and posterolateral aspects of the fibular head, and the direct arm of the short head of the biceps femoris tendon attaches to the more anteromedial aspect of the fibular head, with the anterior arm of the short head attaching along the superolateral edge of the lateral tibia [36].

On MRI, the insertions of the direct arms of the short and long heads are often seen as a single low-signal-intensity structure on coronal T2-weighted images [32] (Fig. 5), and as mentioned earlier, the biceps femoris tendon is often joined by the fibular collateral ligament just above their insertions to form a conjoined insertion [32, 33, 35]. Injuries to the biceps femoris tendon are often seen in conjunction with posterolateral corner injuries; include myotendinous junction tears above the level of the knee and soft-tissue or bone avulsion from the fibular head [28, 32] (Fig. 6); and are best shown on coronal and axial MR images.

The Popliteus Musculotendinous Complex and Popliteofibular Ligament

The popliteus muscle is a major dynamic stabilizer of the lateral knee and arises from the posterior medial proximal tibia, extending superiorly and laterally to form a tendon that continues into the joint through the popliteal hiatus, deep in relation to the fabellofibular and arcuate ligaments [33, 35–37]. The popliteus tendon has a major insertion at the anterior aspect of the popliteal sulcus of the lateral femoral condyle, anterior and inferior to the femoral origin of the fibular collateral ligament [29]. The popliteus tendon also sends fibers to insert on the posterior horn of the lateral meniscus (anteroinferior, posterosuperior, and posteroinferior popliteomeniscal fascicles) that form a strong attachment to the posterior horn lateral meniscus around the popliteal hiatus [28, 37] and prevent the lateral meniscus from excessive forward displacement during knee extension [31].

The popliteus tendon and muscle are best seen on axial and coronal images as low- and intermediate-signal-intensity structures, respectively (Figs. 7 and 8). Although avulsions at the femoral insertion may occur, injuries of the popliteus muscle and tendon usually involve the muscle belly or musculotendinous junction [37]. Because this area is a challenge for the arthroscopist to view, the radiologist plays a key role in making this diagnosis. Partial tears of the musculotendinous junction appear as amorphous increased signal intensity within the tendon and muscle. Disruption of fibers, enlargement of the muscle belly, or both may be present [33] (Figs. 9A and 9B).

The existence of a consistent attachment of the popliteal tendon to the fibular head is well established and is called the popliteofibular ligament. This structure originates near the popliteus musculotendinous junction and courses distally and laterally to attach to the medial aspect of the fibular styloid process and is thought to be present in most knees as an important static stabilizer of the posterolateral corner [10, 25, 38, 39]. The popliteofibular ligament originates from the popliteus tendon just distal to the popliteomeniscal fascicles and proximal to the popliteus musculotendinous junction and extends distally to insert on the anterior downslope of the medial aspect of the fibular styloid process, near to the tibiofibular joint [28–30]. This ligament is a short, strong tendinous band that is as wide as or even wider than the popliteus tendon [39]. Despite this fact and the fact that this ligament is present in most, if not all, knees, the popliteofibular ligament is only variably visualized on MRI [34, 36]. The ligament can sometimes be seen as a small low-signal-intensity structure on coronal (Fig. 10) and sagittal (Fig. 11) images and can occasionally be followed over several images in the axial imaging plane (Fig. 12). In one study, the use of a coronal

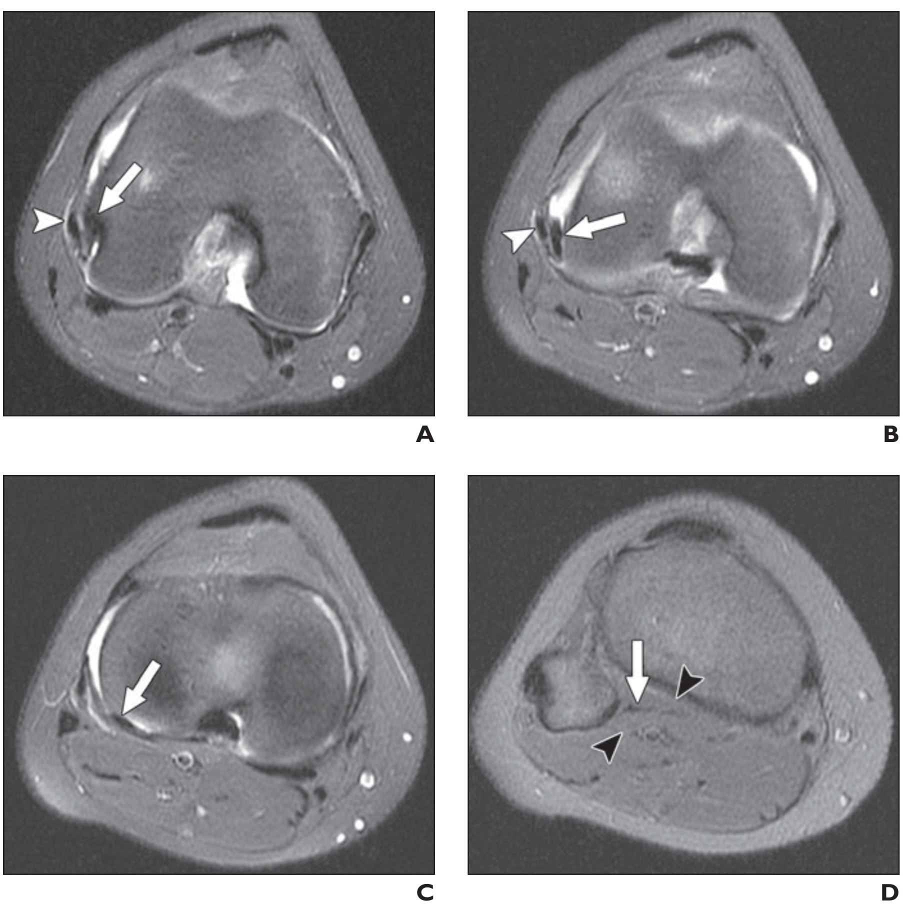


Fig. 7—Normal popliteus tendon and muscle in 15-year-old girl.
A–D, Axial fat-suppressed fast spin-echo T2-weighted images (TR/TE, 3,750/46) show normal appearance of popliteus tendon (*arrows*) and muscle belly (*black arrowheads*, **D**) and relationship between popliteus tendon and fibular collateral ligament (*white arrowheads*, **A** and **B**).

oblique imaging plane compared with a standard coronal plane improved visualization of this ligament from 8% to 53% of knees [27]. Injury may be detected as increased signal within the ligament, discontinuity, or avulsion of the ligament off of the fibular styloid (Fig. 13) and is best visualized on coronal or coronal oblique views [28].

The Lateral Head of the Gastrocnemius Tendon and the Fabellofibular Ligament

The tendon of the lateral head gastrocnemius is located at the far lateral aspect of the lateral gastrocnemius muscle–tendon unit, and injuries to this structure are rare [28]. The fabella is a variably present sesamoid bone in the lateral head gastrocnemius tendon, and the fabellofibular ligament is also variably present, found in approximately 40% of knees in two anatomic studies [30, 40] and identified on approximately one third of MRI examinations in one study [35]. This ligament is a thickening of the distal edge of the capsular arm of the short head biceps femoris muscle [28]. Proximally, its origin is from the lateral margin of the fabella, if a fabella is present, or from the posterior aspect of the supracondylar process of the femur [30]. Distally, the fabellofibular ligament inserts on the posterior and lateral edges of the fibular styloid process, anterolateral to the insertion of the popliteofibular ligament [30, 36].

The fabellofibular ligament is occasionally visualized on MRI and is best seen on coronal T2-weighted images as a low-signal structure located posteriorly with respect to

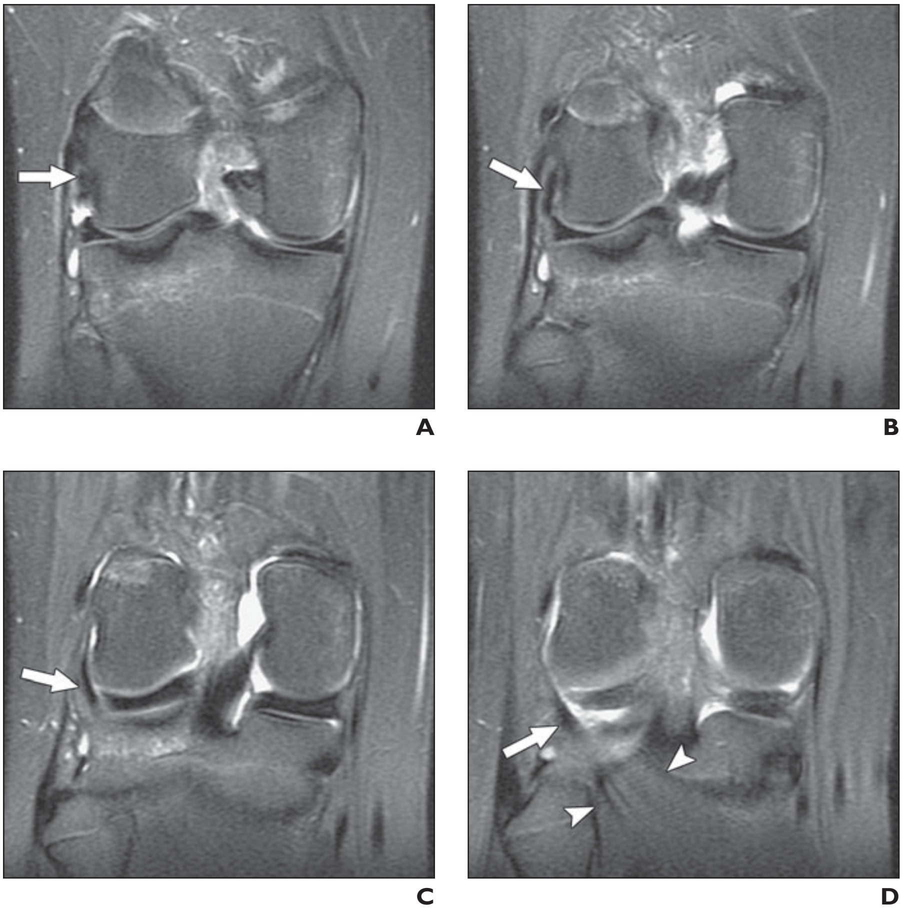


Fig. 8—Normal popliteus tendon and muscle in 15-year-old girl.
A–D, Coronal fast spin-echo T2-weighted images (TR/TE, 3,950/49) depict normal popliteus tendon (*arrows*) and popliteus muscle belly (*arrowheads,* **D**).

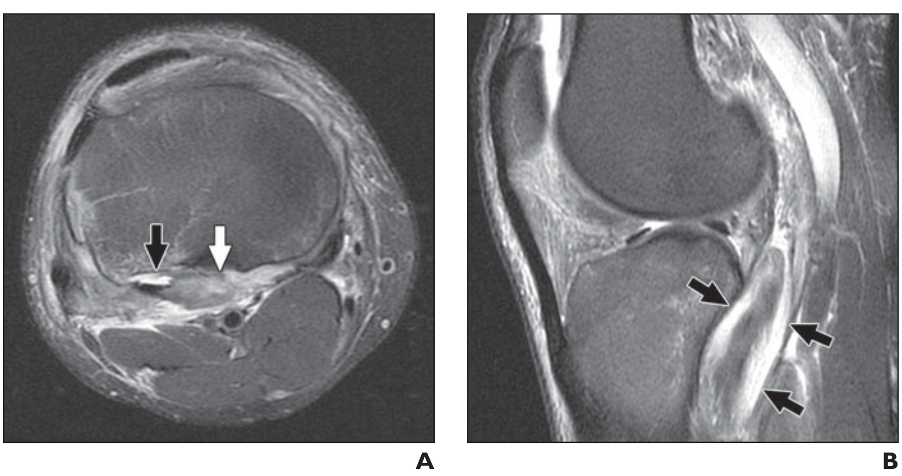


Fig. 9—Popliteus injury in 51-year-old man.
A, Axial fat-suppressed fast spin-echo T2-weighted image (TR/TE, 4,000/69) shows fluid signal adjacent to popliteus musculotendinous junction (*black arrow*), consistent with partial tear, and increased signal intensity, consistent with injury, within visualized popliteus muscle belly (*white arrow*).
B, Sagittal fat-suppressed fast spin-echo T2-weighted image (4,000/50) shows fluid signal extending along margins of popliteus muscle belly (*arrows*), consistent with partial tear.

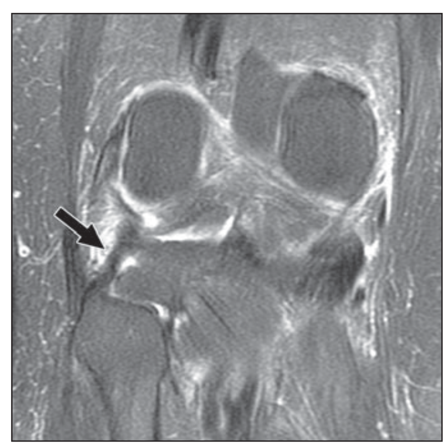


Fig. 10—Intact popliteofibular ligament in 75-year-old woman. Coronal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 4,117/69) shows prominent intact popliteofibular ligament (*arrow*) extending from popliteus tendon to fibular styloid process.

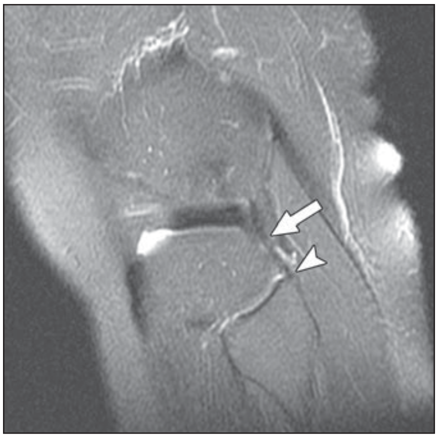


Fig. 11—Intact popliteofibular ligament in 60-year-old woman. Sagittal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 3,900/50) depicts popliteofibular ligament (*arrow*) inserting on fibular styloid process (*arrowhead*).

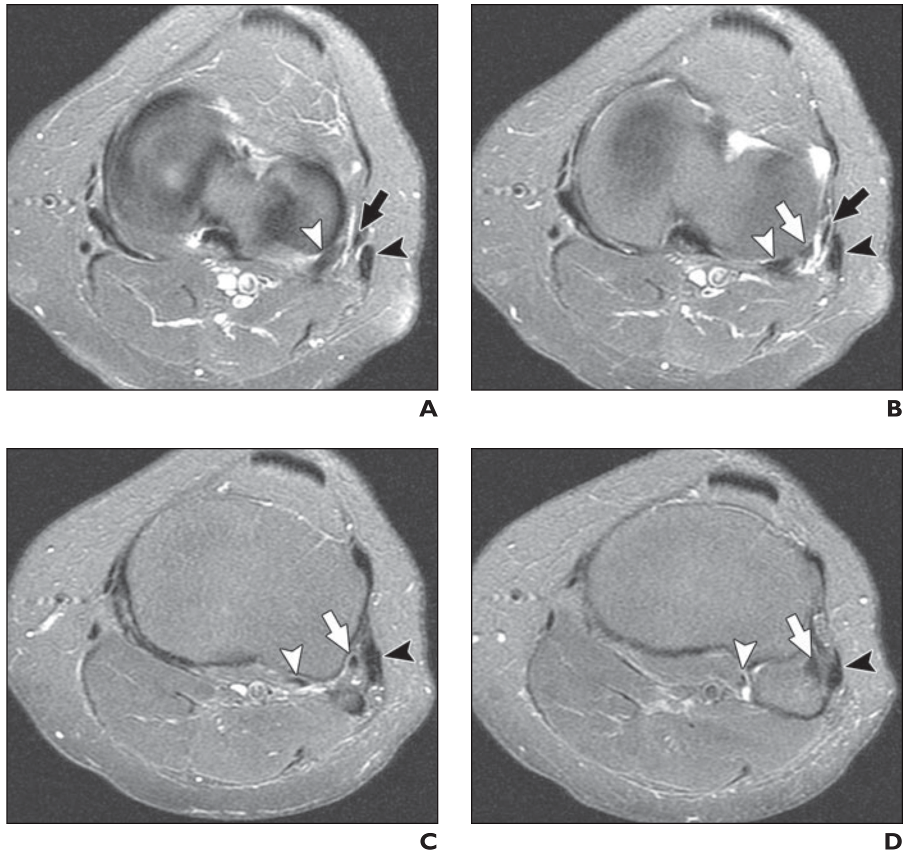


Fig. 12—Normal popliteofibular ligament in 60-year-old woman.
A–D, Axial fat-suppressed fast spin-echo T2-weighted images (TR/TE, 4,350/50) show intact popliteofibular ligament (*white arrows*, **B–D**) and its relationship to popliteus tendon (*white arrowheads*), fibular collateral ligament (*black arrows*, **A** and **B**), and biceps femoris tendon (*black arrowheads*).

the fibular collateral ligament [35] (Fig. 14). MR evidence of injury includes distal avulsion from the fibular styloid process, which can be seen concurrently with avulsion of the direct arm of the short head of the biceps femoris tendon, thickening, and increased signal intensity [28]. Because of the infrequency with which this ligament is well visualized in even noninjured knees, it is not as useful as some of the other structures in the evaluation for posterolateral corner injuries with MRI.

The Arcuate Ligament

The arcuate ligament is a variably present Y-shaped structure with medial and lateral limbs, both of which insert distally at the apex of the fibular styloid process just anterior to the fabellofibular ligament. Several anatomic series have reported the presence of at least one of the limbs as between 47.9% and 71% of knees [30, 36, 40, 41]. The lateral, or upright, limb extends superiorly along the joint capsule to the lateral femoral condyle, and the medial, or arcuate, limb extends superomedially, over the popliteus muscle, to merge with the posterior capsule [31, 33, 36].

The arcuate ligament is, in general, difficult to visualize on MRI [35, 36]. However, it can be thought of as a thickening of the posterolateral capsule, a portion of which forms the bowed roof of the popliteal hiatus [31, 36], and can be seen as a low-signal structure on axial images (Fig. 15). Inspection of the posterolateral joint capsule on axial MR images at the level of the joint line may reveal gross disruption (Fig. 16), implying injury to or a tear of the arcuate ligament. The medial limb occasionally can be visualized immediately posterior to the popliteus tendon, just below the level of the popliteal hiatus, on sagittal images [36]. As we mentioned earlier, some authors advocate the use of a coronal oblique imaging plane to improve visualization of this ligament complex, with visualization using that plane in 46% of pa-

Fig. 13—Torn popliteofibular ligament in 27-year-old man. Coronal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 3,500/65) shows avulsion of distal popliteofibular ligament (*arrow*) from fibular styloid process (*arrowhead*).

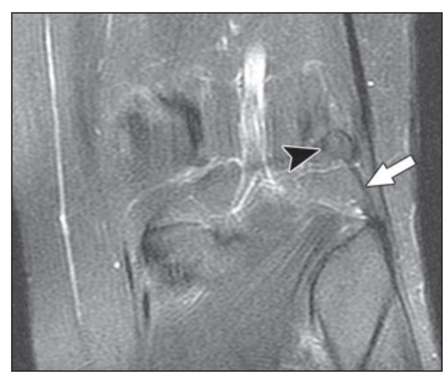


Fig. 14—Normal fabellofibular ligament in 43-year-old woman. Coronal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 3,450/69) depicts normal fabellofibular ligament (*arrow*), which extends from fabella (*arrowhead*) to fibular styloid process.

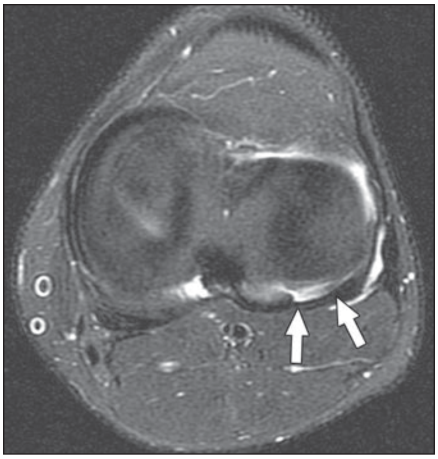


Fig. 15—Intact arcuate ligament in 20-year-old man. Axial fat-suppressed fast spin-echo T2-weighted image (TR/TE, 4,450/74) at level of joint line shows arcuate ligament (*arrows*) is intact.

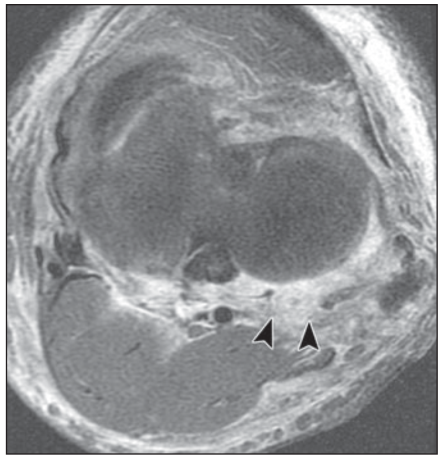


Fig. 16—Torn arcuate ligament in 53-year-old man. Axial fat-suppressed fast spin-echo T2-weighted image (TR/TE, 4,000/49) shows tear of posterolateral joint capsule (*arrowheads*) at level of joint, which is consistent with arcuate ligament tear.

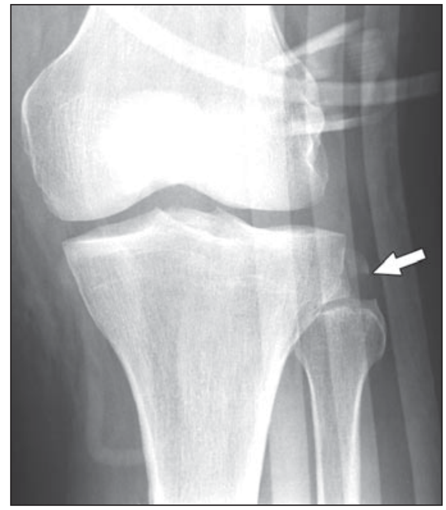


Fig. 17—Arcuate fracture in 55-year-old man. Frontal radiograph shows knee with fracture of fibular styloid process (*arrow*).

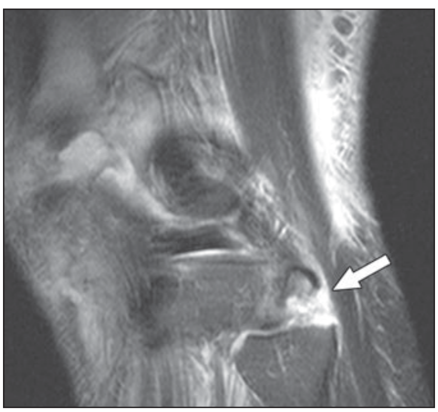


Fig. 18—Arcuate fracture in 55-year-old man. Sagittal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 4,000/75) depicts avulsion fracture of fibular styloid process (*arrow*), which is also called "arcuate" fracture.

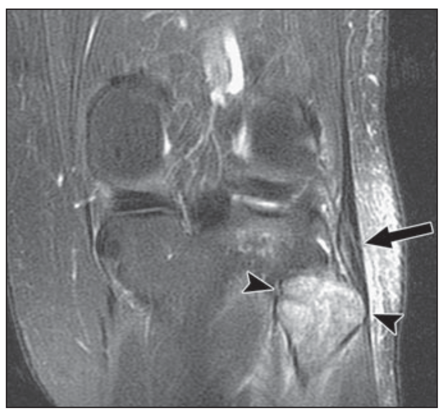


Fig. 19—Fibular head edema in 34-year-old woman. Coronal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 4,000/70) shows edema in fibular head (*arrowheads*). There is increased signal, consistent with injury, in distal biceps femoris tendon (*arrow*).

tients in one series [27]. Some studies have noted an association between posterolateral corner injuries and a lack of significant joint effusion on MRI; this association is thought to be due to the presence of disruption of the posterior lateral joint capsule [23].

The "Arcuate" Fracture

The popliteofibular, fabellofibular, and arcuate ligaments attach distally to the fibular styloid process. An avulsion fracture of this styloid process, the so-called "arcuate" sign, often indicates injury to one or more of these ligaments and thus to the posterolateral corner. This fracture may be seen on anteroposterior or lateral knee radiographs as a small displaced bone fragment [42, 43] (Fig. 17). On MRI, the fracture fragment may be more difficult to identify (Fig. 18). The term "arcuate" sign has also been applied to larger avulsion fractures of the fibular head in the region of the conjoined structure insertion [43, 44]. Even in cases without an evident fracture, MRI may reveal edema either localized to the fibular styloid process, suggesting injury to the popliteofibular, fabellofibular, or arcuate ligament, or more diffuse edema in the lateral aspect of the fibular head, suggesting injury to the fibular collateral ligament, biceps femoris tendon, or both [43] (Fig. 19).

Anterior Medial Tibial Margin Fracture

Fractures of the peripheral anteromedial tibial plateau have also been described to occur in the setting of posterolateral corner injury. One study detected this relatively uncommon fracture in six of 16 knees with clinical and MRI evidence of posterolateral corner injury [22]. In two of these cases, the fracture resulted from hyperextension with forced varus angulation, and in the remaining four, the fracture resulted from a direct blow to the anteromedial tibia with the knee flexed [22]. Cohen et al. [45] suggested a mechanism of varus rotation and posterior tibial translation that results in disruption of both the posterolateral corner and PCL and allows the anterior medial femoral condyle to impinge on the anteromedial tibial plateau, resulting in fracture of the anteromedial tibial rim. Given its association with posterolateral corner injuries, an anteromedial tibial plateau fracture seen on either radiography or MRI should prompt close clinical and imaging evaluations of the posterolateral corner structures.

Bone Marrow Contusion

MRI fluid-sensitive sequences are superb in detecting bone marrow contusions. In one series of six patients with acute posterolateral knee injuries, a characteristic bone marrow contusion on the anteromedial femoral condyle was seen in the five patients with complete posterolateral complex disruption [23]. This contusion is best seen as increased signal intensity in the subchondral bone marrow of the weight-bearing surface of the anterior aspect of the medial femoral condyle on sagittal T2-weighted images and is thought to be due to a hyperextension varus type of injury [23, 32] (Fig. 20).

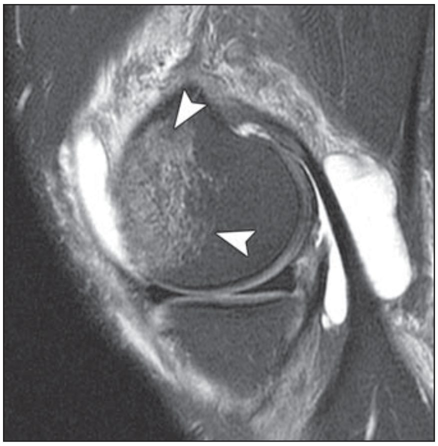


Fig. 20—Medial femoral condyle contusion in 48-year-old man. Sagittal fat-suppressed fast spin-echo T2-weighted image (TR/TE, 3,750/69) shows increased signal intensity within bone marrow of anterior aspect of medial femoral condyle (*arrowheads*), consistent with hyperextension varus contusion.

Conclusion

Being aware of the normal and abnormal MRI appearances of the structures of the posterolateral corner of the knee and of the patterns of injury often seen in patients with posterolateral corner rotatory instability will help radiologists suggest the diagnosis of posterolateral corner injury even when not clinically suspected. Although we may not be able to accurately define when instability exists with imaging alone, available data indicate that tears of two or more of the posterolateral structures—most importantly, the fibular collateral ligament, the popliteus musculotendinous unit including the popliteofibular ligament, and the posterolateral joint capsule—suggest the diagnosis of a high-grade posterolateral corner injury and should direct the orthopedic surgeon to carefully examine for posterolateral corner rotatory instability in the pre- or perioperative setting because urgent repair or reconstruction is associated with better functional outcomes. This diagnosis is especially important in the setting of combined injuries because unrecognized and unaddressed posterolateral corner injuries may contribute significantly to ACL and PCL graft failure. Unrecognized and untreated high-grade posterolateral corner injuries have also been shown to lead to significant posttraumatic osteoarthritis in the affected knee [8, 15]. Conversely, injury to only one of the posterolateral structures supports the presence of a grade I or II injury, which, depending on the presence of associated injuries, can often be successfully treated nonsurgically.

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