The Acutely Injured Knee

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KEYWORDS

• Knee pain • Effusion • Ligament tear

KEY POINTS

- Detailed history, including age, onset of symptoms, history of trauma or overuse, duration of symptoms, rheumatologic conditions, and previous therapy, is important in narrowing the differential diagnosis.
- Physical examination and radiographic imaging are important in identifying conditions, such as extensor mechanism injuries and tibial plateau fractures, that require prompt referral to an orthopedic surgeon.
- Due to its high sensitivity and specificity in detecting common injuries, magnetic resonance imaging has become the diagnostic modality of choice in diagnosing soft tissue abnormalities of the knee.
- Initial treatment centers on analgesia and includes nonsteroidal anti-inflammatory drugs and cryotherapy and, if necessary, brief periods of immobilization.
- Timely diagnosis is important because time to operative intervention can have a significant effect on surgical outcomes, patient recovery, and satisfaction.

INTRODUCTION

Active lifestyles, including participation in athletic activities, have been promoted as a means of improving physical and mental health. However, engaging in athletic activity is not without peril. Musculoskeletal-related injuries are a leading source of morbidity among physically active individuals. Musculoskeletal ailments are responsible for nearly 21.5% of visits presenting to primary care offices[1] and 13.8% of emergency room visits.[2]

Symptoms within the knee prompt more visits to ambulatory clinics than any other musculoskeletal region except the lumbar spine and account for 1.5% of all ambulatory care visits.[3] In a study conducted by the US Department of Health and Human Services, knee symptoms cause more visits than headaches, depression, and hypertension and equal those due to chest pain.[3]

Although a large percentage of knee pain can be attributed to chronic conditions such as osteoarthritis, acute knee pain is a common ailment treated in primary care

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clinics. The differential diagnosis can be broad and ranges from tibial plateau and patella fractures to ligamentous or tendinous ruptures to meniscal and articular cartilage injuries. Several of these injuries, such as injuries to the extensor mechanism (quadriceps/patellar tendon ruptures, patella fractures), require prompt treatment by an orthopedic surgeon to avoid permanent dysfunction. A general knowledge of the diagnosis of these entities and overall treatment strategy is imperative to avoid long-term disability caused by delay in appropriate treatment of these injuries.

HISTORY

A comprehensive history helps narrow the differential diagnosis. A detailed history should include the following aspects: patient age, nature and location of pain, effusion and its onset, mechanical symptoms (ie, locking and/or catching), ability to bear weight, history of a traumatic event, documented dislocation requiring reduction, recent alterations in activity level, previous musculoskeletal injuries and/or surgeries, underlying rheumatologic and medical conditions, and systemic symptoms.

Onset of symptoms is important to assist in diagnosis and triage. Any penetrating injury should be identified and, if there is any question of joint involvement, further investigation preferably at an emergency department should be performed to prevent possible later development of septic arthritis. A history of a specific traumatic event, especially when associated with an effusion or swelling, should raise the suspicion for fracture or injury to a ligament, tendon, meniscus, and/or articular cartilage and should prompt more urgent referral to an orthopedic surgeon. Meanwhile, pain developing after a more insidious history such as recent increase in exercise or overuse more likely results in tendinopathy, patellofemoral symptoms, or stress fracture. Sudden fevers and overall malaise associated with an effusion often indicates septic arthritis, especially if a recent infection elsewhere. In elderly patients without a known traumatic event, osteoarthritis is likely the cause of pain. **Table 1** presents specific injuries with commonly reported mechanisms.

PHYSICAL EXAMINATION

Although the literature often focuses on provocative tests for specific pathologic abnormalities, physical examination should begin with the basics of any musculoskeletal

Table 1
Common acute knee injuries and their usual mechanism

Injury	Mechanism
ACL tear	Noncontact twisting injury with acute effusion and pain
Posterior cruciate ligament (PCL) tear	"Dashboard" injury when tibia struck, or fall onto tibia with foot plantarflexed
Medial collateral ligament (MCL) strain/tear	"Clipping" injury when lateral blow to knee causes valgus stress
Patella fracture	"Dashboard" injury when patella directly struck, or fall onto tibia with foot dorsiflexed
Meniscal tear	Twisting or squatting injury associated with specific medial or lateral pain and catching/locking
Quadriceps or patellar tendon rupture	Sudden hyperflexion causing sudden forceful quadriceps contraction and immediate inability to perform straight-leg raise

evaluation: observation, palpation, range of motion, motor strength, sensation, vascular, ligamentous testing/stability, and provocative maneuvers. The culmination of examination findings is much more reliable than specific testing alone.[4] The injured knee should always be compared with the contralateral limb.

Before evaluation of the affected limb, general overall ligamentous laxity should be assessed. The ability to touch thumbs to the forearm, hyperextend the elbow, and knee recurvatum are signs of increased laxity, which predisposes affected individuals to patellar dislocations and other generalized sprains.[5]

Inspection is ideally performed with full exposure of bilateral lower extremities. If the patient is able, gait and alignment should be assessed with shoes and socks removed for full appreciation of ankle and foot position. An obvious deformity that appeared after a recent traumatic event is concerning for a condition requiring prompt treatment, such as a fracture or dislocation. The skin should be carefully inspected for previous surgical scars, which offer insight to previous procedures. Localized swelling, ecchymosis, and effusion clue the examiner into location of injury. Localized swelling and ecchymosis can result from a direct blow or underlying injury, while an effusion heralds an intra-articular process such as an ACL tear. ACL tears account for greater than 70% of injuries among those with an acute effusion and a history of a noncontact twisting injury.[6]

Because of the superficial location of many important structures about the knee, palpation plays a large diagnostic role in the assessment of knee injuries. Palpation around the knee joint should proceed systematically and include all bony prominences. Joint line tenderness, according to some studies, is the most accurate predictor of a meniscal tear.[7] Extensor mechanism injuries can be diagnosed solely on physical examination: an inability to extend the knee actively and a palpable defect at the superior or inferior pole of the patella is pathognomonic for quadriceps and patellar tendon ruptures, respectively, and can eliminate the need for magnetic resonance imaging (MRI).

Range of motion of the hip and knee should be measured actively and passively. Normal knee motion with the patient supine ranges from 0° to 10° of hyperextension to 125° to 135° of flexion. Hip rotation is limited when the knee is extended, but, when the knee is flexed to 90°, normal hip internal and external rotation measure 30° and 45°, respectively. Acute loss of passive knee motion suggests a significant structural injury, such as a tibial plateau fracture or ligamentous rupture, while loss of active but not passive motion signals an injury to the dynamic musculotendinous unit.

Neurovascular testing should be performed bilaterally and include specific testing of major arteries and peripheral nerves, including femoral, superficial, deep peroneal, and tibial nerves. Specific testing for each peripheral nerve is presented in **Table 2**. A peroneal nerve palsy, commonly manifested as a drop foot, is frequently associated with an injury to the lateral collateral ligament (LCL). Strength or sensory testing that does not correspond to a specific nerve distribution may correspond to an underlying lumbar radiculopathy. The popliteal, dorsalis pedis, and posterior tibialis pulses

Table 2
Motor and sensory testing for major peripheral nerves of lower extremity

Nerve	Motor	Sensory
Femoral	Knee extension	Medial leg and foot (saphenous)
Deep peroneal	Ankle and great toe dorsiflexion	Dorsal first web space
Superficial peroneal	Hindfoot eversion	Dorsal lateral foot
Tibial nerve	Ankle plantarflexion	Plantar surface foot

should be palpated and any discrepancy warrants further investigation. Posterior knee pain, foot swelling, or calf tenderness is concerning for deep vein thrombosis and venous duplex should be considered.

Stability and provocative tests form the core of knee physical examination. Commonly used tests are described in Table 3. Ligamentous stress tests are performed with the knee relaxed and are gauged by the amount of excursion/laxity and quality of the end point.

DIAGNOSTIC TEST/IMAGING

Orthogonal radiographs are currently the preferred initial imaging study to evaluate acute knee injuries. Radiographs, which are more readily available and relatively inexpensive, are important to identify fractures that would require immediate treatment or referral to an orthopedic surgeon. Weight-bearing as tolerated is generally safe without risking further derangement if no femoral or tibial fracture is defined on radiographs. Radiographic assessment should include anteroposterior and lateral views at

Table 3
Commonly used knee physical examination tests

Structure	Test	Description
ACL	Lachman	Anteriorly directed force on the tibia applied with the knee flexed to 30°.
	Anterior drawer	Anteriorly directed force on the tibia applied with the knee flexed to 90°.
PCL	Posterior drawer	Posteriorly directed force on the tibia applied with the knee flexed to 90°.
	Quadriceps active	Patient actively contracts quadriceps while lying supine, hip flexed to 45°, and knee flexed to 90°. Tibia shifts anteriorly with an insufficient PCL.
MCL	Valgus stress	Laterally directed force applied to tibia. Test is performed at 0 and 30° of knee flexion. Laxity at 30° of flexion indicates injury to MCL, whereas laxity at 0° of flexion suggests injury to medial structures.
LCL	Varus stress	Medially directed force applied to tibia. Test is performed at 0 and 30° of knee flexion. Laxity at 30° of flexion indicates injury to LCL, whereas laxity at 0° of flexion suggests injury to lateral structures.
Patellar instability	Patellar apprehension	Laterally directed force applied to patella causes apprehension and feeling that patella is subluxing/dislocating.
	Patellar translation	Laterally directed force applied to patella. Lateral translation of the medial border of the patella to the lateral edge of the trochlear groove or further is usually considered abnormal but should be compared with contralateral patella.
Meniscal tear	Apley's compression	Reproducible pain in medial or lateral joint line when combined compressive and rotational force (varus/external rotation for medial meniscus; valgus/internal rotation for lateral meniscus) applied with patient in the prone position and knee flexed to 90°.

Table 4
Sensitivity and specificity of MRI in detecting common acute knee injuries

Injury	Sensitivity (%)	Specificity (%)
ACL tears	78–91	85–100
PCL tears	100	97
Medial meniscal tears	91–100	52–90
Lateral meniscal tears	56–82	83–99

Data from Refs.[11,13,14]

a minimum. Merchant views offer an axial image of the patella and can provide useful information following patellar dislocations but require knee flexion angles of 45°.

The Ottawa rules have been developed to guide primary care clinicians in appropriate ordering of radiographs following development of acute knee symptoms.[8] Based on the Ottawa rules, radiographs should be obtained in those presenting with acute knee pain if (1) patient age is greater than 55 years old, (2) there is tenderness at the fibular head, (3) there is patellar tenderness, (4) there is an inability to flex knee to at least 90°, (5) there is an inability to bear weight for a minimum of 4 steps.[8] If one or more of these findings are present, the sensitivity of detecting a fracture is 1.0 and specificity of 0.54 according to the sentinel study.[8]

MRI has the ability to image meniscal, ligamentous, tendinous, and chondral structures optimally within the knee joint (**Table 4**) and is considered the gold standard imaging study for detecting soft tissue injuries within the knee. In addition, bone bruises on MRI have the ability to provide insight on injury pattern (**Fig. 1**). Given that most injuries in the knee involve soft tissue structures, some have advocated for the routine use of MRI early in management. Recent studies have suggested that obtaining a limited MRI at the time of initial evaluation shortens the time to completion of diagnostic workup, reduces the number of additional diagnostic procedures, improves quality of life in the first 6 weeks, and may reduce costs associated with lost productivity.[9,10] No significant advantage has been attained with the use of a 3-T MRI versus 1.5-T MRI in detecting common acute knee injuries.[11] Intra-articular contrast may

Fig. 1. Bone bruising patterns can assist in identifying injury patterns. For example, bone contusions involving the center of the lateral femoral condyle and posterior lateral tibial plateau (*A*) suggest a pivot-shift mechanism, which often results in an ACL tear (*B*). *Arrow* indicates site of ACL tear.

improve the characterization of meniscal tears,[12] but, due to the accuracy of conventional MRI in detecting injury, is generally deemed unnecessary.

Within the knee, computerized tomography (CT) is largely reserved to define fractures detected using plain radiographs further. Three-dimensional imaging has become an important component for preoperative management of tibial plateau fractures (**Fig. 2**). This imaging modality delineates a fracture that is underestimated in severity in 43%[15] and modifies treatment in 60%[16] when added to standard radiographic imaging.

Although ultrasonography has gained recent popularity because of its increasing availability, lack of ionizing irradiation, and decreased cost compared with MRI, its use in the knee has been limited because of the difficulty imaging around bony structures. Historically, the primary use of ultrasound in the management of acute knee injury has been to confirm injuries to the quadriceps and patellar tendons. However, one recent report has demonstrated the high reliability of ultrasonography in detecting meniscal tears.[17]

DIFFERENTIAL DIAGNOSIS

Knowledge of the knee anatomy and function can assist in formulating the differential diagnosis for a patient presenting with acute knee pain. Because of the relative simplicity of the knee's hinged design and superficial location, thorough history and thoughtful physical examination based on knowledge of known anatomic structures can narrow the potential diagnoses before imaging studies are obtained. Subjective and objective pain localized to a specific area of the knee often indicates injury adjacent to the sight of the described pain. **Table 5** lists differential diagnoses of acute injuries based on location.

Knee effusions and hemarthroses are common findings following acute knee injury and portend an increased probability of ultimate surgical intervention. In a recent study of an adolescent population, an acute knee effusion was associated with a 41% chance of surgery.[18] Injuries, such as tibial plateau and patellar fractures, cruciate

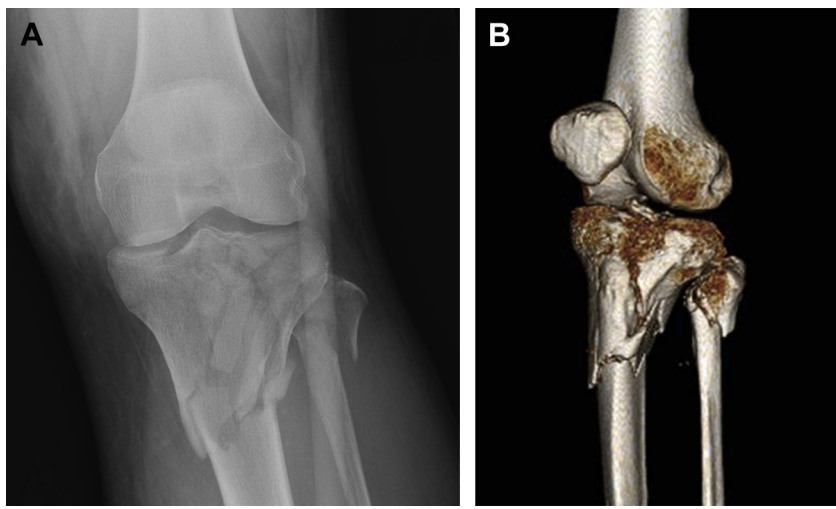

Fig. 2. Although radiographs are useful in identifying a tibial plateau fracture (*A*), CT scan, especially those with 3-dimensional reconstruction, provide more detail of fracture pattern (*B*).

Table 5
Differential diagnoses of acute knee injury based on location

Medial	Lateral	Anterior
Medial meniscal tears	Lateral meniscal tears	Patellar or quadriceps tendon rupture
Chondral/osteochondral injuries of medial femoral condyle	Chondral/osteochondral injuries of lateral femoral condyle	Chondral/osteochondral injuries of trochlea or patella
MCL sprains/tears	LCL sprains	Patellar or quadriceps tendon tendinitis
Distal pes anserinus tendon strains	Distal biceps femoris/popliteus tendon strains	Patella fractures
MPFL sprains/tears	Lateral retinacular tears	
Medial tibial plateau fractures	Lateral tibial plateau fractures	

ligament tears, peripheral meniscal tears, and traumatic patellar dislocations, involve vascularized intra-articular structures and are often associated with intra-articular effusions secondary to hemarthroses. Septic arthritis should be considered in any acute effusion associated with a fever and no significant traumatic event. Meanwhile, extra-articular injuries (eg, collateral ligament injuries) tend to cause focal swelling more than global effusions.

TREATMENT

The most important purpose of evaluation is efficiently differentiating between injuries that (1) require prompt surgical evaluation and treatment by an orthopedic surgeon, (2) need less urgent evaluation by an orthopedic surgeon, and (3) can be managed effectively by a primary care physician. Displaced intra-articular fractures (eg, tibial plateau fractures and patellar fractures) and tendon ruptures (eg, quadriceps and patellar tendon tears) are often treated surgically within 7 to 10 days and therefore benefit from immediate referral to an orthopedic surgeon for management. Differentiating these maladies from other less urgent entities is crucial in ensuring appropriate management of acute knee injuries.

Although the differential diagnosis for acute knee injury can be broad, initial treatment does not vary significantly between injuries. Regardless of ultimate diagnosis, those patients presenting with an acute knee effusion or moderate or severe pain often benefit from temporary immobilization in full extension using either a knee immobilizer or a hinged knee brace. Immobilizers, which are designed to prevent knee flexion, are often less costly initially. However, hinged braces can be locked in extension or unlocked to allow motion, which may be beneficial later in the treatment course. The period of immobilization should be balanced between need for stability versus potential for muscle atrophy,[19] arthrofibrosis, and altered ligamentous healing.[20,21] For most injuries, immobilization of the knee should be limited to 1 week unless the knee is grossly unstable due to fracture or multiligamentous injury. If the injury is serious enough to require prolonged immobilization, prompt referral to an orthopedic surgeon is appropriate. Studies have indicated that an immobilization period as short as 5 days is associated with muscle atrophy.[22]

In addition to immobilization, pain from knee effusions can be managed with nonsteroidal anti-inflammatory drugs (NSAIDs), ice, and aspiration. NSAIDs have both analgesic and anti-inflammatory properties but also have antiplatelet activity and

potentially can cause increased bleeding, which may be detrimental in conditions at risk for compartment syndrome, such as tibial plateau fractures. Cryotherapy has been shown to produce significant decreases in pain,[23,24] but clinicians should caution patients about the potential for frostbite with inappropriate use.[25,26] Aspiration of an acute hemarthosis remains a controversial practice. Although some advocate aspiration of a hemarthosis to aid in diagnosis, alleviate pain, and facilitate rehabilitation,[27] others have questioned the practice because of the potential for infection and lack of efficacy. A review of 267 papers was unable to provide a definitive answer of the effectiveness of aspiration.[28]

Most patients with an acute knee injury can be allowed to progressively weight-bear as tolerated with or without bracing depending on the injury. The decision to allow weight-bearing, however, should be based on the results of initial radiographs: those with a known or suspected intra-articular fracture of the weight-bearing surfaces of the knee (ie, tibial plateau fractures, femoral condyle fractures) should avoid weight-bearing to prevent displacement of the fracture.

Although most acute knee injuries can be initially treated with a similar protocol centered on pain control, the ultimate treatment of these injuries varies based on the condition. A brief discussion of overall treatment strategies for common acute knee injuries is presented.

ACL Tears

ACL ruptures are associated with an acute hemarthosis, which limits knee motion within the first 2 weeks. Regardless of the eventual treatment plan, initial treatment measures are directed at restoring painless range of motion and preserving quadriceps strength. Physical therapy has been shown to be beneficial to accomplish these goals, especially among those wishing to proceed with surgical reconstruction.[29]

Not all who sustain ACL tears will develop clinical instability. Therefore, the decision to undergo surgical reconstruction of the ACL is based on several factors. Many patients without meniscal, acute chondral, or concomitant ligamentous injury are “copers” and have minimal functional difficulty after recovering from the initial trauma following ACL tear, or are “adapters” and modify their activities to prevent instability episodes.[30] Those patients opting for nonoperative management of an ACL tear must be aware of the potential long-term ramifications of their treatment choice. Several studies have demonstrated an increased risk of irreparable medial meniscal tears and osteochondral injuries[31,32] and therefore concerns for increased potential for progression to osteoarthritis long-term.[33]

Surgical treatments have metamorphasized considerably over the past 3 decades. Historical studies assessing direct ACL repairs reported high rates of decreased activity levels and unacceptable function.[34] Therefore, surgical reconstruction, not surgical repair, is the preferred treatment of ACL insufficiency (**Fig. 3**). Various graft options, including autografts and allografts, exist and each graft’s benefits and risks must be weighed to provide optimal treatment. Although allografts do not suffer from problems associated with graft harvest, they are associated with higher rerupture rates, especially in younger populations.[35] Patellar tendon, hamstring tendon, and quadriceps tendon autografts have acceptable rerupture rates and initial strength[36]; however, they are limited by donor-site morbidity, such as anterior knee pain, posterior thigh pain, and quadriceps weakness, respectively.

Postoperative arthrofibrosis is an uncommon but major concern following ACL reconstruction. Therefore, most surgeons advocate delaying ACL reconstruction until the acute hemarthrosis has resolved and range of motion has been restored following the initial injury.[37] Furthermore, aggressive postoperative rehabilitation initiated within

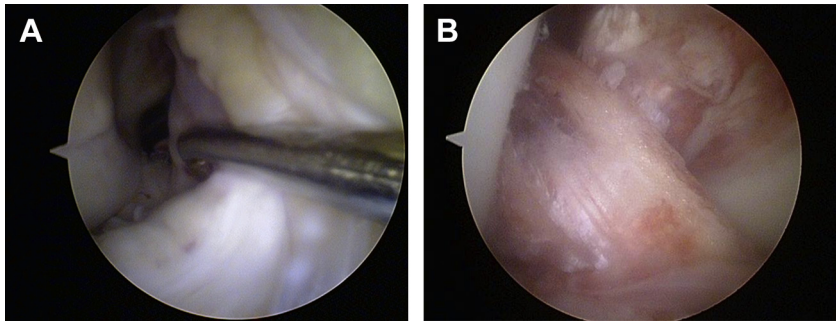

Fig. 3. Most ACL injuries are femoral avulsions that produced an empty lateral wall of the notch (*A*). In the past, repair was attempted but its poor long-term results have made reconstructions (*B*) the favored surgical treatment of ACL reconstructions.

the first 2 to 3 weeks has been shown to improve ultimate outcomes and decrease postoperative stiffness.[38]

Posterior Cruciate Ligament

A key to treating PCL injuries is to identify the entire injury pattern. Although isolated PCL injuries can successfully be treated nonoperatively,[39] PCL ruptures associated with other ligamentous knee injuries are more significant entities often treated operatively. Careful examination of the entire lower extremity is critical to avoid missing a potential limb-threatening injury, such as a popliteal artery tear.

Nonoperative treatment of isolated PCL injuries includes a therapy program that focuses on quadriceps strengthening, which assists anterior translation of the tibia. Long-term studies of nonoperatively managed PCL ruptures report increased rates of degenerative arthritis in the patellofemoral and medial compartments.[40]

Several surgical options exist for treatment of symptomatic PCL injuries. With the exception of bony avulsions, which are treated with open reduction and internal fixation, most PCL ruptures treated operatively are reconstructed. Reconstructions can be performed arthroscopically using a tunnel through the tibia or open through a posterior approach and using an inlay technique. The debatable biomechanical advantage of the inlay technique must be balanced by its increased potential morbidity.[41]

Postoperative rehabilitation progresses much more slowly than ACL reconstructions. In particular, hamstring contraction, which tends to exert a posterior force on the tibia, is deferred for up to 4 months postoperatively.

Medial Collateral Ligament

Often considered to be the most commonly injured knee ligament, the MCL rarely requires surgical intervention even if associated with an ACL injury. Most MCL injuries can be successfully treated with early mobilization and bracing using a hinged knee brace. Unlike the ACL, which is exposed to synovial fluid, the MCL is considered to have a robust blood supply and thought to be capable of adequate healing.

The decision for surgical intervention is based on the degree of laxity. Usually, only those injuries with valgus laxity in full extension are considered for operative intervention. Complete MCL avulsions of the tibial insertion can be treated acutely with direct surgical repair (**Fig. 4**), whereas most midsubstance and femoral avulsions are initially managed nonoperatively and undergo delayed reconstruction if necessary.

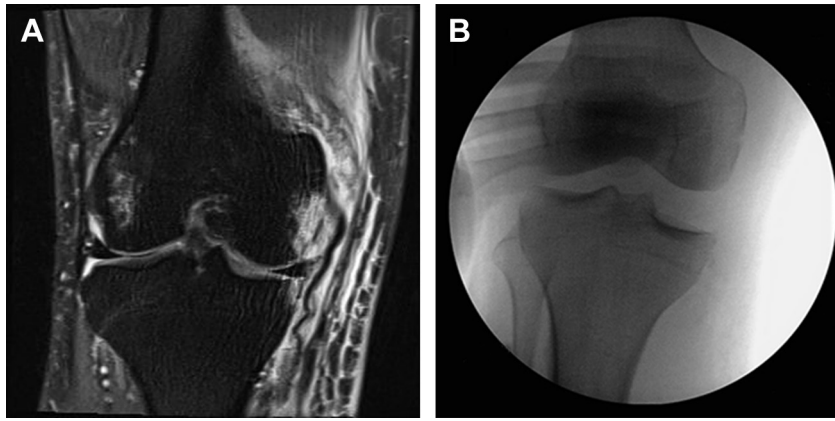

Fig. 4. Most MCL injuries are treated with a trial of nonoperative management. However, complete tibial-sided avulsions (*A*), especially those with significant medial gapping with stress (*B*), are often treated with early direct repair.

Bracing is considered long-term in groups that are at high risk for sustaining valgus-type injuries (eg, football linemen). There is evidence that supports prophylactically bracing this population to prevent MCL injury.[42]

Knee Dislocations and Multiple Ligament Injuries

Knee dislocations are an emergency and require immediate relocation to prevent catastrophic damage to the affected limb. Although fixed dislocation is obvious on physical examination, subluxations (**Fig. 5**) and dislocations with spontaneous reductions can be subtle but equally devastating. Therefore, a high level of vigilance is required for those with a PCL injury and suspected multiligamentous knee injury. A thorough vascular examination, including pulses, capillary refill, and ankle-brachial indices (ABIs), is important in identifying potential vascular injuries. In particular, ABIs are highly predictive of vascular injury following knee dislocations and ABIs less than 0.9 are associated with increased risk of vascular injury and should prompt formal vascular imaging.[43]

Knee dislocations typically occur in 3 groups: athletes, those involved in a motor vehicle accident, and the morbidly obese. Of those, the morbidly obese carry a higher risk of neurovascular injury[44] and should warrant even more thorough monitoring and aggressive imaging, especially given the limitations of physical examination in this population.

Treatment is directed largely on injury pattern and patient characteristics. Younger, physically demanding patients typically opt for surgical intervention to optimize their outcome. Initial treatment includes immobilization in a brace versus surgical application of a spanning external fixator in cases wherein a concentric reduction cannot be maintained (**Fig. 6**). If further surgical intervention is indicated and no other injuries prohibit surgery, most surgeons prefer to operate once the capsule has healed (ie, roughly 3–4 weeks).[45] Although ACL and PCL ruptures are often reconstructed, collateral ligaments can be reconstructed or repaired depending on the degree of injury, location of injury, and time from injury to surgery. Allografts are the generally preferred graft choice in the setting of multiligamentous injuries due to donor-site morbidity in the already severely injured knee. Postoperative rehabilitation proceeds slowly in this population, and full recovery takes in excess of 1 year.

Fig. 5. Knee subluxations (*A*) and dislocations should be promptly reduced. Inability to reduce the knee closed should raise concerns over entrapped MCL and medial structures (*B*). In these cases, open reduction may be necessary to achieve an anatomic reduction (*C*).

Meniscal Tears

Meniscal tears vary greatly in their morphology and resultant limitation. Although most meniscal tears can be managed conservatively for weeks, months, or even years, bucket-handle tears and others causing restrictions in knee range of motion require prompt treatment to prevent long-term stiffness. Bucket-handle tears are long vertical tears that involve a large segment of the meniscus. The large fragment, usually the posterior horn and body of the meniscus, can flip and lodge within the notch and anterior to the femoral condyle (Fig. 7). This "locked" position of the meniscus limits knee extension and often requires surgical manipulation to reduce the meniscus.

Meniscal tears are relatively common in asymptomatic adults and, unless causing mechanical symptoms or associated with a ligamentous injury, can often be treated by a trial of nonoperative management. In one study, meniscal tears were detected in 36% of asymptomatic adult knees.[46] Furthermore, meniscal tears are often associated with osteoarthritis and may not be the source of pain. Studies have demonstrated only two-thirds of patients with severe osteoarthritis who underwent arthroscopic partial meniscectomy had pain relief initially and, within 5 years, only 40% reported

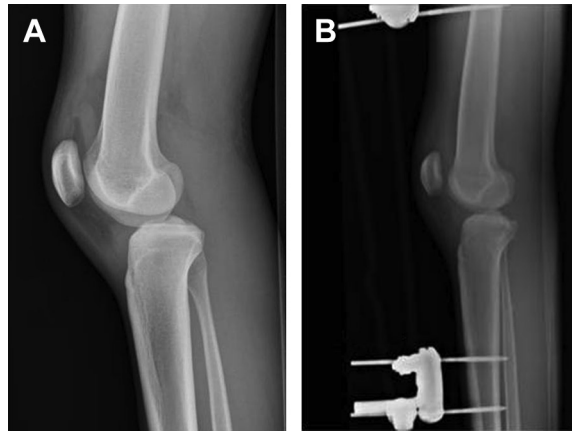

Fig. 6. Nonconcentric reductions, especially with posterior sag on lateral radiographs (*A*), should be treated with closed reduction and external fixation (*B*) to prevent compression of posterior neurovascular structures.

improved symptoms and 32% required total joint replacement or unloading osteotomy.[47] Therefore, surgical intervention in older adults should be reserved for those with a meniscal tear and relatively well-preserved articular cartilage that have mechanical symptoms and/or have failed an initial trial of nonoperative management, including physical therapy, NSAIDs, and/or injections.

Preservation of the meniscus is important to limit the progression of degenerative arthritis. Although preferable biomechanically, meniscal repair is often not possible due to the configuration of the tear and the poor blood supply of the meniscal tissue. Furthermore, recovery from a meniscal repair is lengthy compared with partial meniscectomy, in which weight-bearing as tolerated is allowed immediately following surgery. Location of the tear within 2 mm of the capsule, vertical tears less than 4 cm in length, and an associated ACL tear and concomitant reconstruction are factors most favorable for successful repair.[48,49] If a favorable milieu is present and repair is possible, especially in a young patient, early referral to an orthopedic surgeon is recommended to prevent progression of the tear.

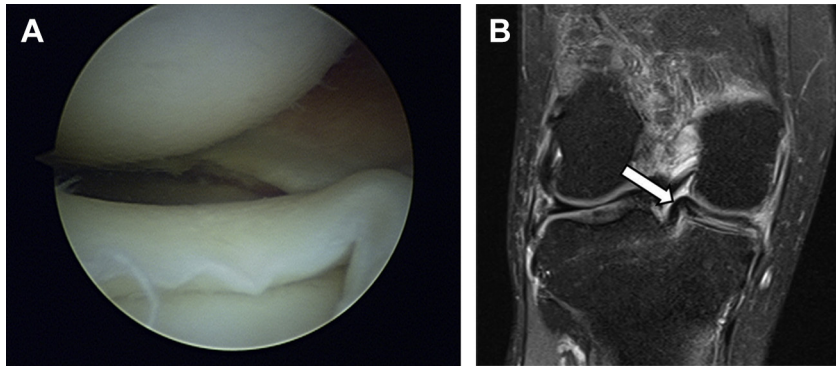

Fig. 7. Bucket-handle tears (*A*) frequently cause locking and can be identified on MRI as a fragment within the notch adjacent to the PCL (*B*). *Arrow* indicates Bucket-handle meniscus tear displaced into notch.

Patellar Dislocations

Patellar dislocations have a broad spectrum of injury. Although patellar instability can occur with minimal provocation in those with increased ligamentous laxity, dislocations in those with normal ligamentous laxity are typically more violent, can result in significant cartilaginous sheer injuries, and therefore, should be considered for MRI after initial injury. Unless imaging studies demonstrate a traumatic osteochondral body or bony avulsion, physical therapy focusing on quadriceps and core strengthening and J-bracing is the preferred initial management of most patellar dislocations.

The historical surgical treatment of recurrent patella dislocation has varied widely from tibial tubercle transfer to lateral retinacular release to medial capsular plication. The understanding that the medial patellofemoral ligament (MFPL) is the primary stabilizer of lateral patellar translation has revolutionized the treatment of patellar dislocations (**Fig. 8**). Most current surgical strategies for patellar dislocation are based on repair or reconstruction of the MPFL. Although delayed MPFL reconstructions using either hamstring autograft or allograft have produced excellent functional outcomes,[50,51] acute repair of the torn MPFL within adolescents does not confer any clinical benefit when compared with nonoperative management with physical therapy.[52]

Extensor Mechanism Injuries

Prompt recognition and referral of injuries to extensor mechanism, including quadriceps tendon, patella, and patellar tendon, are important to attain optimal clinical outcomes. Because of the unopposed proximal pull of the quadriceps musculature, disruptions of the extensor mechanism can be difficult to repair if surgery is delayed for greater than 2 to 3 weeks. In cases of acute disruption, the tendons can be directly repaired, whereas, in chronic cases, more extensive procedures such as interpositional grafts or advancement flaps may be required.

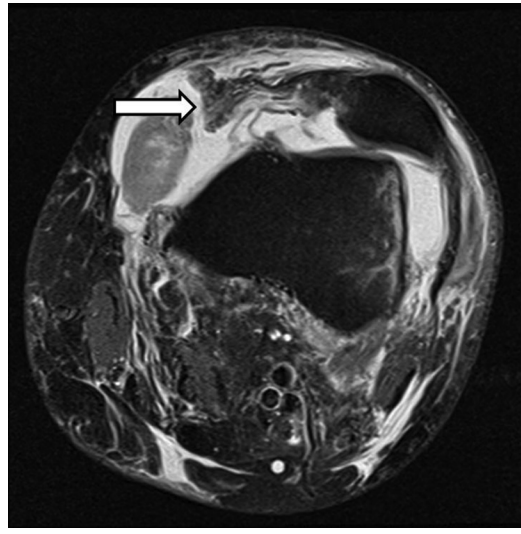

Fig. 8. The MPFL runs from the adductor tubercle of the medial femoral condyle to the superior two-thirds of the medial patella and can be compromised mid substance or at its patellar or femoral attachment (as shown here) during an acute traumatic patellar dislocation. *Arrow* indicates Torn edge of medial patellofemoral ligament.

Inability to perform a straight leg raise and a palpable defect are hallmarks of extensor mechanism and should prompt further investigation. Radiographs readily detect patellar fractures and patellar tendon disruptions where the patella is elevated (ie, patella alta) compared with the contralateral limb (Fig. 9). Because physical examination and radiographs can diagnose most of these injuries, MRI is often unnecessary and can delay definitive treatment. For comfort and to prevent distraction of the proximal and distal segments, the knee should be immobilized in extension before referral to an orthopedic surgeon.

Tibial Plateau Fractures

Tibial plateau fractures occur in 2 distinct subsets: in elderly patients, tibial plateau fractures are often caused by low-energy falls, whereas in younger populations, these injuries result from high-energy trauma, such as motor vehicle accidents. Vascular injuries and compartment syndrome are not uncommon among those sustaining high-energy injuries. In addition to this population, elderly with seemingly low-energy fractures but who are consuming antiplatelet agents and/or anticoagulants should be closely monitored for potential compartment syndrome.

Treatment of tibial plateau fractures is based on number, location, and amount of displacement of the fracture fragments. Nondisplaced fractures are often treated with a period of immobilization and non-weight-bearing. Although the precise amount of acceptable displacement remains controversial, unstable fractures with significant joint incongruity benefit from open reduction and internal fixation once soft tissue swelling subsides.[53]

Chondral and Osteochondral Injuries

Most chondral and osteochondral injuries are likely subclinical and occur insidiously. When symptomatic, these injuries are often associated with mechanical symptoms,

Fig. 9. Extensor mechanism injuries are often diagnosed by physical examination alone. Radiographs can be useful, especially in patellar tendon ruptures in which the patella migrates superiorly because of the unopposed action of the quadriceps.

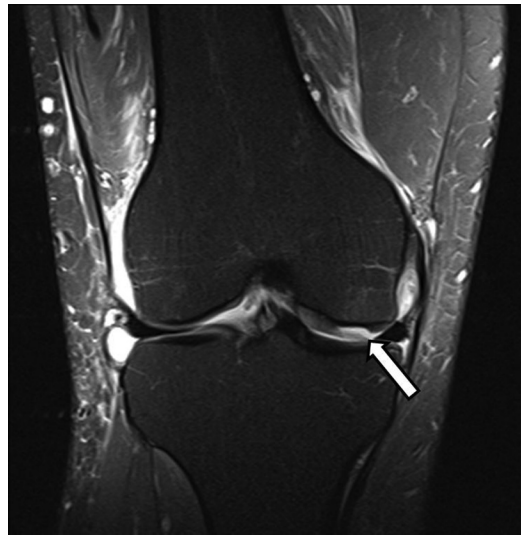

Fig. 10. Delamination injuries of the articular cartilage can cause the unstable fragment to flip and cause locking and catching sensations. *Arrow* indicates delaminated edge of articular cartilage.

such as locking and catching (**Fig. 10**). Usually, acute lesions with mechanical symptoms benefit from surgical intervention to prevent locking and potentially restore native anatomy. Osteochondral fragments are typically more amenable to surgical fixation than chondral lesions because of thickness and purchase of the osseous portion. If repair is not possible, the fragment is often removed from the joint. Delayed cartilage restoration can be considered if the patient remains in pain.

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