Knee Dislocations

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M.N. Doral, J. Karlsson (eds.), *Sports Injuries*,
DOI 10.1007/978-3-642-36569-0_123

Abstract

A knee dislocation is a potentially devastating injury that must be managed appropriately from initial presentation through potentially several interventions and surgeries. A high suspicion for neurovascular injuries should be maintained at all times, and just because it is not obvious at initial presentation does not mean that one has not occurred. Surgical management should be well thought out and planned because complications such as wound problems, compartment syndrome, neurovascular injury, and stiffness are more common than in less severe extremity injuries.

Introduction

Knee dislocations can be among the most devastating injuries to the lower extremity and are true orthopedic emergencies. A knee dislocation is defined as a disruption of the normal anatomic relationship of the distal femur and proximal tibia, and it necessarily involves injury to two or more of the ligamentous supporting structures about the knee (Kennedy 1963; Brautigan and Johnson 2000; Klimkiewicz et al. 2001; Rihn et al. 2004). A knee dislocation may present as an occult dislocation or "subluxation" that has occurred and spontaneously reduced, or as a gross deformity and persistent dislocation of the tibiofemoral joint. In addition to ligamentous injury, neurovascular injuries are frequent with knee dislocations, occurring in anywhere from 15 % to 50 % of these injuries, and they are associated with poor outcome (Green and Allen 1977; Shelbourne and Klootwyk 2000; Wascher 2000; Stannard et al. 2004). A knee dislocation may also involve significant meniscal and capsular injury and may or may not have an associated fracture. Dislocations are frequently caused by high-velocity trauma, but can result from seemingly minimal trauma such as a misstep from a curb with a low-velocity knee dislocation due to morbid obesity; so one must maintain a high index of suspicion when evaluating patients (Azar et al. 2011). Treatment options have evolved from initial nonoperative treatment to continually evolving surgical and arthroscopic techniques with increasing awareness of procedure timing after injury.

Anatomy

There is minimal stability conferred by the bony anatomy of the knee, as most of the stability is due to the ligamentous structures, including the two bundles of the anterior cruciate ligament (ACL), the anteromedial (AM) and posterolateral (PL) bundles, the two bundles of the posterior cruciate ligament (PCL), and the anterolateral (AL) and posteromedial (PM) bundles, along with the anterior and posterior meniscofemoral ligaments, the medial collateral ligament (MCL), and fibular (lateral) collateral ligament (FCL) including the posterolateral corner structures (PLC). The posterolateral corner generally refers to the iliotibial band (ITB), the biceps femoris, the FCL, the popliteus muscle and tendon, the popliteofibular ligament, the fabellofibular ligament, and the lateral joint capsule.

Several neurovascular structures run in close proximity to the knee joint and have a high potential for injury at the time of knee dislocation. Structures within the popliteal fossa, including the popliteal artery, popliteal vein, and tibial nerve, are immediately adjacent to the posterior capsule just to the lateral of midline and can all be subject to injury (Kim et al. 2010). They are particularly vulnerable because they are tethered above and below the knee by the adductor hiatus and the gastrocnemius-soleus arch, respectively. The common peroneal nerve, which courses deep to the biceps femoris and then runs superficial to the fibular head as it courses anteriorly and distally in the leg, is also at high risk for being injured as it courses over the lateral aspect of the fibular head.

Classification

Many classification systems exist for knee dislocations. The most common description of knee dislocations is directional and refers to the tibial

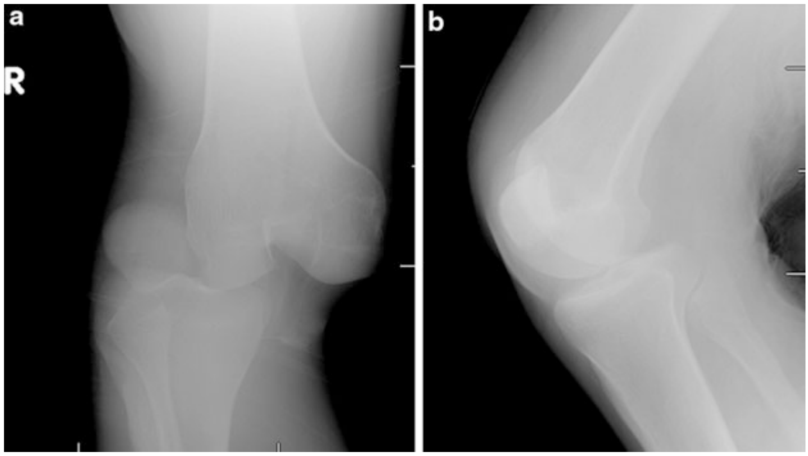

Fig. 1 (**a**) AP X-ray of a lateral knee dislocation. (**b**) Lateral X-ray of a lateral knee dislocation

displacement relative to the femur (Kennedy 1963). In decreasing order of incidence, these are described as anterior, posterior, lateral, medial, and rotatory, with rotatory being subdivided into anteromedial, anterolateral, posteromedial, and posterolateral (Kennedy 1963; Green and Allen 1977; Fig. 1a, b). This type of classification however fails to take into account occult or spontaneously reduced knee dislocations.

Several other methods of classification have also been developed including those based on mechanism of injury and perceived "high"- and "low"-energy mechanisms (Shelbourne et al. 1991a, Hagino et al. 1998). Anatomic classification of knee dislocations has been described by Schenk and ranges from disruption of one cruciate ligament (KD-I) to disruption of all four knee ligaments (KD-IV) (Eastlack et al. 1997). In this classification system, a concomitant fracture is indicated by (KD V) and associated neurologic and arterial vascular injury represented by (N) and (C), respectively (Eastlack et al. 1997).

Due to the severe, unique, and complicated nature of knee dislocations, most of these injuries are not accurately represented by these classification systems. Therefore, it is preferred to describe knee dislocations based on timing of presentation, acute versus chronic; based on specific anatomic structure injured, along with grade of injury; and based on specific description of concomitant neurologic or vascular injury (Harner et al. 2004). An example of the above is a patient whose radiographs can be seen in Fig. 2a, b. This patient sustained an acute, occult knee dislocation, involving a grade three injury to the proximal MCL, a grade three ACL midsubstance injury, a fibular head avulsion fracture, and a bony avulsion of the tibial PCL and was neurovascular intact (Fig. 2a, b).

Evaluation

History and Clinical Presentation

Knee dislocations can present in many different circumstances ranging from an obese patient limping into the physician's office after a slip and fall having sustained a knee dislocation or "subluxation" with spontaneous reduction, to a person in a high-speed motor vehicle collision brought to the emergency room with obvious gross deformity to the knee joint and to anywhere in between including during sports participation. Despite knee dislocation being a rare event, a high index of suspicion for this injury must be maintained. Knee dislocations may be missed if the evaluating physician underestimates the severity of knee injury based on injury mechanism alone or if the treating physician is distracted by other life-threatening injuries after a severe trauma. Regardless of presentation, a detailed and systematic workup must be initiated immediately in order to diagnose and treat any potentially limb-threatening neurovascular injuries.

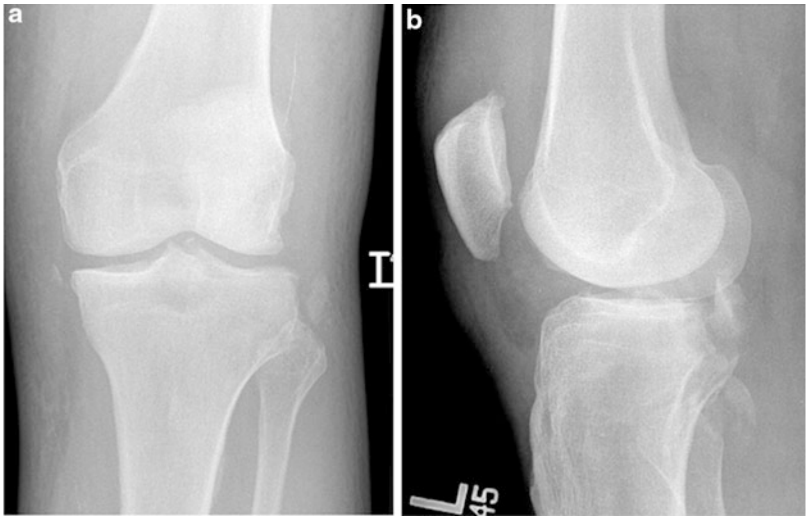

Fig. 2 (**a**) AP X-ray of an occult knee dislocation with fibular head fracture and PCL avulsion fracture. (**b**) Lateral X-ray of occult knee dislocation with fibular head fracture and PCL avulsion fracture

The direction of force at the time of injury will dictate the structures that are injured and the position of dislocation. Anterior dislocations most frequently result from a hyperextension mechanism (Kennedy 1963; Green and Allen 1977; Gustilo and Cabatan 1993). At approximately 30° of hyperextension, injury to the posterior capsule is initiated. This is followed by injury to the ACL and PCL as the severity of hyperextension increases, with injury to the popliteal artery occurring after 50° of hyperextension (Kennedy 1963).

Posterior dislocations are the result of a posteriorly directed force to the anterior tibia (Green and Allen 1977). These injuries can frequently occur due to a blow to the anterior tibia while playing sport or due to a dashboard injury in a motor vehicle collision (Taylor et al. 1972; Gustilo and Cabatan 1993). The PCL is the main restraint to posterior forces and is necessarily disrupted in posterior knee dislocations. The patella and/or the extensor mechanism and the ACL are also frequently injured (Kennedy 1963).

Medial, lateral, and rotatory dislocations are typically due to varus, valgus, and combined forces, respectively (Gustilo and Cabatan 1993). These types of knee dislocations are frequently occult and usually present with a slightly subluxed knee rather than a grossly dislocated knee. Medial dislocations more commonly present with an associated fracture and, as such, must always be concerned for a knee dislocation with evidence of a medial tibial plateau fracture on imaging (Brautigan and Johnson 2000). Lateral knee dislocations are frequently complicated by injury to the common peroneal nerve and have the potential to be unable to be reduced due to the medial femoral condyle "buttonholing" through the medial capsule (Taylor et al. 1972). In this scenario, the patient will likely present with gross deformity about the knee joint and with a "dimple sign," indicative of the medial capsular tissues being trapped in the joint (Taylor et al. 1972).

Lastly, the patient with a knee dislocation may present with a cold leg without pulses, a warm leg without palpable pulses, or a dusky appearance to the skin below the injury level at the knee. They may also present complaining of numbness on the dorsum of the foot and/or inability to dorsiflex or plantar flex the ipsilateral foot. Whatever the clinical presentation may be, the clinician must have a high suspicion for neurovascular insult and must immediately evaluate these structures with the physical exam and further diagnostic studies as indicated.

Physical Examination

A complete and systematic examination is mandatory when there is a clinically apparent knee dislocation, or concern for occult knee dislocation, so that injuries are not missed. Initial management will depend on the overall condition of the patient and the clinical setting at the time of primary evaluation. Whether treating an athlete at a sporting event with a dislocated knee, or seeing a patient in the emergency room with the same injury, the patient should be managed according to Advanced Trauma Life Support (ATLS) protocol, and once airway, breathing, and circulation are confirmed, an attempt to reduce the dislocated knee should be made.

The initial musculoskeletal examination begins with inspection. The skin should be examined for any lacerations or traumatic arthrotomies. The color of the skin should also be closely examined distally to the injury for any evidence of vascular insufficiency. Any dimpling of the anteromedial knee should be noted as mentioned above, this could represent an irreducible dislocation (Taylor et al. 1972). The condition of the soft tissues of the entire lower extremity should also be noted with a high degree of suspicion for an associated compartment syndrome.

Neurovascular Examination

A complete neurovascular examination must be carried out. Any active bleeding or expanding hematoma is indicative of a possible popliteal artery injury. Two mechanisms of arterial injury have been described. With an anterior dislocation and hyperextension deformity to the knee joint, the popliteal artery is stretched and this traction can cause intimal tears to the vessel. This patient may have intact pulses initially with apparent distal perfusion; however, late thrombosis can occur placing the entire limb in jeopardy. With a posterior dislocation, there is a greater likelihood of popliteal artery transection or tearing (Green and Allen 1977). A vascular surgeon should be consulted immediately to evaluate this injury.

Distal pulses, including posterior tibial and dorsalis pedis pulses, should be checked; however, palpable pulses alone cannot rule out an arterial injury. These pulses should be compared to the contralateral limb. Serial ankle–brachial index (ABI) exams should be checked for both lower extremities and compared as well. Any side-to-side difference, or absolute value of less than 0.9, should be treated as a likely vascular injury, and further workup should be initiated. If there is no difference, then the ABI exams should be frequently repeated to ensure that late signs of vascular compromise do not develop.

In place of serial exams, some authors now recommend angiographic studies, for example, CT angiogram, regardless of physical exam findings (Seroyer et al. 2008; Fig. 3). This is controversial because many surgeons argue that these invasive vascular studies are not warranted in patients without clear signs of vascular injury on physical exam. In a recent study by Mills et al., ABI exams demonstrated 100 % sensitivity, specificity, and positive predictive value in that all patients with an ABI of greater than 0.9 had no vascular injury and all patients with an ABI of less than 0.9 had a vascular injury (Mills et al. 2004). Nevertheless, if there is any question about potential vascular injury, a CT angiogram should be obtained.

After the evaluation of the patient's vascular status, attention should be turned to the neurologic examination and, more specifically, evaluation of the common peroneal nerve. Common peroneal nerve injuries are reported to occur in between 14 % and 35 % of knee dislocations (Hegyes et al. 2000). Nerve injury ranges from stretch injury, to complete disruption of the nerve. Whether evaluating a patient immediately after injury on the field of play, in the emergency department, or several days later in the clinic, the timing of nerve dysfunction is critical to evaluate and consider. Examination consists of sensory and motor evaluation distal to the knee injury, specifically assessing at the sensation distribution over the dorsum of the foot and ankle and great toe dorsiflexion. If the patient states that sensation and motor function were intact immediately after the injury and have deteriorated since that time, concern for expanding hematoma is warranted and emergent decompression should be considered. Documentation of nerve function is also important preoperatively so that there is no question about the status of the nerve prior to surgical

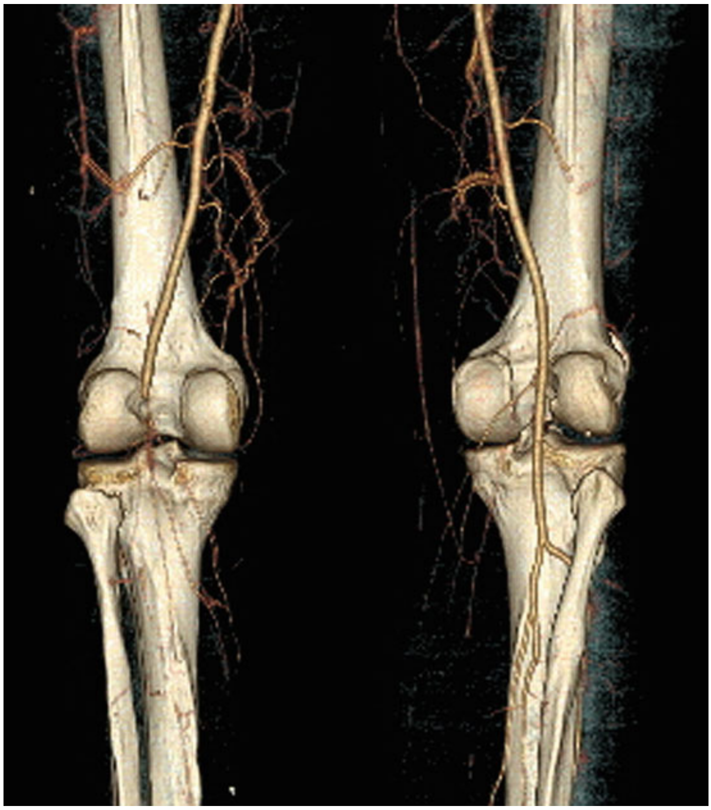

Fig. 3 Three-dimensional reconstruction of CT angiogram to evaluate for arterial injury after knee dislocation. The knee on the left has discontinuity of the popliteal artery in the posterior knee indicating injury at that level

intervention. Many of these nerve injuries have a poor prognosis despite maintaining nerve continuity, with less than 50 % of patients regaining any useful nerve function (Niall et al. 2005).

Knee Examination

Lastly, examination of the knee should be carried out, but may be difficult due to the acute and devastating nature of the injury. Alignment should be assessed and the knee should be confirmed to be reduced. Comparison to the contralateral, uninjured knee should be performed and may give important information when considering surgical intervention with regard to the patient's native coronal plane alignment. One must always consider that the contralateral knee may be injured also an attempt at a straight leg raise may be performed and gives important information about the extensor mechanism. The knee may only have a limited range of motion, but any crepitus should alert the examiner to possible fracture. A large effusion may be present, but may also be reduced due to significant capsular injury. The ligamentous examination can be performed with a pillow under the injured knee for the patient's comfort, and in this position, varus, valgus, and a Lachman examination can be performed with reasonable accuracy. The knee can generally be flexed to 50° or 60°, and the normal 1 cm anterior "step-off" of the medial tibial plateau relative to the medial femoral condyle should be felt for. If this "step-off" is reduced or absent, then injury to the PCL is likely. Varus and valgus stress tests can be performed at both full extension, evaluating cruciate and capsular integrity, and 30° of flexion, where the collateral ligaments are isolated. Rotational evaluation may be very difficult with an acute injury especially at 90° of flexion; however, increased tibial external rotation at 30° of flexion should raise concerns for a posterolateral corner (PLC) injury or a severe medial knee injury.

Imaging

Initial imaging of the dislocated knee should consist of plain radiographs, at least anteroposterior and lateral views of the knee in question. Except in cases of vascular compromise, an attempt at a closed reduction should not be delayed until radiographs are obtained. Initial radiographs should be closely inspected for any small changes in coronal or sagittal plane alignment. Fractures, including fracture of the fibular head or tibial plateau, are common and should raise concern for the severity of injury. Reduction of the knee must be confirmed on X-ray examination, and if reduction is not possible, then the patient should be taken to the operating room where reduction may be fluoroscopically confirmed and reduction maintained with external fixation as necessary. A CT scan may also give added information about fractures and reduction of the tibiofemoral joint, and if a CT angiogram is obtained for vascular evaluation, then this information is readily available.

After initial evaluation including neurovascular examination and confirmation of reduction on radiographs or CT, an MRI should be obtained to further detail the injury to the involved extremity. MRI allows for detailed evaluation of ligamentous structures about the knee including both cruciate and collateral ligaments. MRI can also give further information about meniscal injury, cartilage damage, and capsular injury.

Initial Management and Treatment Options

Initial Management

Management of the dislocated knee should proceed according to a stepwise algorithm to maximize patient outcome and avoid potential complications. The first priority is that reduction of the knee is emergently attempted and reduction immediately confirmed. If reduction is unable to be maintained by closed means, then operative management is warranted in the form of surgical reduction and placement of external fixation. The use of initial external fixation is indicated for more complex injuries as in cases with associated vascular injury, compartment syndrome, or open dislocations for wound management.

Nonoperative Treatment

Historically, nonoperative treatment was the standard of care for knee dislocations (Kennedy 1963; Taylor et al. 1972); however, more recently, studies have reported improved outcomes with surgical management (Dedmond and Almekinders 2001; Richter et al. 2002). Nonoperative treatment may still be the treatment of choice for some patients with severe injuries to vital organ systems that require attention prior to extremity injuries. A recent meta-analysis by Dedmond et al. showed improved postoperative Lysholm scores in the operatively treated group by almost 20 points when compared to nonoperative treatment (Dedmond and Almekinders 2001). Richter et al. showed similar improvement in outcome scores at 8-year follow-up (Richter et al. 2002). Nonoperative treatment in the literature usually consists of immobilization of the effected extremity in full extension using either a cast or external fixator for 3–6 weeks followed by progressive range of motion.

Operative Management

Preoperative Considerations

After initial treatment and stabilization of a patient with a knee dislocation, further operative treatment is generally warranted, and if any subsequent surgical procedure is to be considered, a venous ultrasound 1 day prior to each procedure can rule out a potentially fatal deep venous thrombosis (DVT) and subsequent pulmonary embolism (PE). Acute treatment of knee dislocations usually involves a combination of direct ligament repair and ligament reconstruction. Graft choices should be considered including ipsilateral quadriceps tendon or patellar tendon autografts or

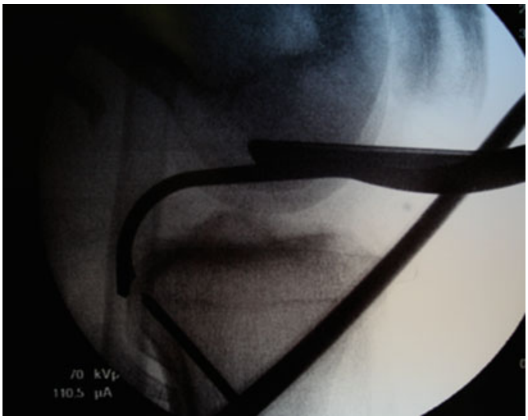

Fig. 4 Intraoperative fluoroscopy for placement of PCL tibial tunnel

contralateral knee grafts. Allografts are generally the preferred graft choice with the advantage of no donor site morbidity, more options for graft sizes, and potentially less operative time during the procedure (Fanelli and Feldmann 1998; Harner et al. 2004; Levy et al. 2009). The use of a tourniquet is contraindicated if vascular injury is present or vascular repair has been performed. Intraoperative fluoroscopy can be an invaluable asset for the assessment of tunnel placement and correction of subluxation during the procedure (Fig. 4).

Surgical Timing: The Staged Approach

The spectrum and variable combination of injuries when dealing with knee dislocations makes it very difficult to follow a rigid algorithm for repair and/or reconstruction of the knee's stabilizing structures. However, when dealing with these injures, one must consider them in terms of four main stabilizing structures of the knee, ACL, PCL, MCL, and posterolateral side.

Due to the complexity of these injuries, a multidisciplinary team approach is necessary. Experienced teams, including surgeons and surgical technicians, are better prepared to deal with the difficult decisions involved in this type of trauma.

An individualized approach to each patient needs to be performed, taking into account the complex and multiple ligament injuries to the knee. The surgeon needs to choose between a single-stage or two-stage procedure considering the benefits of an early surgery and the risks of postoperative stiffness and infection due to external fixation or soft tissue injury (Mohtadi et al. 1991; Shelbourne et al. 1991b; Levy et al. 2010).

As previously mentioned, if external fixation is initially indicated, a definitive approach should be performed from 3 to 6 weeks post-injury. Reconstruction/repair of all ligaments needs to be performed, after soft tissue recovery and the inflammatory response from trauma have decreased (Levy et al. 2010).

Many knee dislocations involve injury to the medial or lateral structures and variable injury to the ACL and/or PCL. When any of the posterolateral corner structures are injured, and the injury is acute (less than 3 weeks), acute direct repair of the biceps femoris, iliotibial band, and lateral capsule is preferred, while reconstruction of the FCL, popliteofibular ligament, and popliteus tendon is recommended (Fig. 5). Reconstruction of the cruciate ligaments can also be concurrently performed.

If the medial side of the knee is acutely injured, then nonoperative management can be initially attempted as long as the MCL remains in close approximation to the femur and tibia. If there is tissue interposed and healing is unlikely (Fig. 6), similar to the Stener lesion in the thumb, in which the distal MCL is flipped over the pes anserinus tendons, then the MCL is acutely repaired or reconstructed and torn cruciate ligaments are concurrently reconstructed to allow for early knee motion. Range of motion and stability are assessed at postoperative visits as for the lateral repairs, and manipulation and/or cruciate ligament reconstruction is undertaken as indicated , if initially delayed. Using this treatment algorithm with medial sided injuries, arthrofibrosis due to early cruciate ligament reconstruction can be avoided.

The patient's range of motion and stability are carefully examined at postoperative visits and serial radiographs are obtained. If postoperative range of motion is poor, manipulation is generally carried out at 10–12 weeks after the initial procedure as indicated.

Fig. 5 (**a**) MRI of posterolateral corner injury with injury to the biceps, LCL, popliteus, and ITB. (**b**) Direct repair of the posterolateral corner structures with a yellow vessel loop around the peroneal nerve

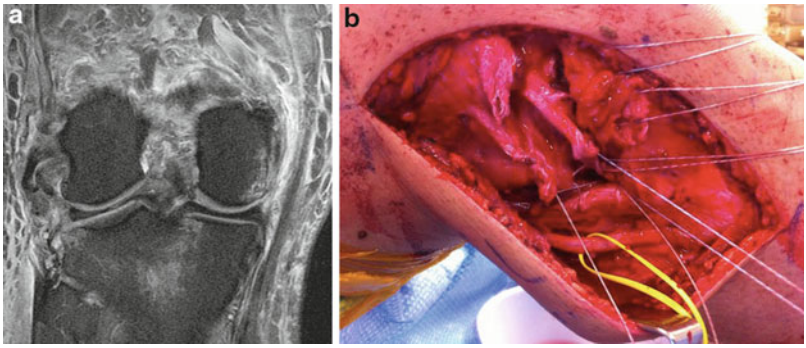

Fig. 6 Tibial avulsion of MCL with proximal retraction

Surgical Timing: Immediate Reconstruction

Most recent studies have shown improved postoperative outcomes with acute reconstructions of the medial and/or lateral sides and of the cruciate ligaments (Noyes and Barber-Westin 1997; Wascher et al. 1999; Harner et al. 2004). Both Noyes et al. and Wascher et al. showed improved patient outcomes in those patients who were treated acutely (Noyes and Barber-Westin 1997; Wascher et al. 1999). Harner et al. showed similar findings with no difference in postoperative range of motion and consistently improved laxity tests in both groups (Harner et al. 2004). Immediate reconstruction can be undertaken, but a high degree of awareness and suspicion for both intraoperative and postoperative complications and swelling must be maintained at all times.

Surgical Technique

Surgical Setup

An examination under anesthesia (EUA) is performed to correlate prior MRI and physical exam findings and to assess for any potential healing of the medial structures or PCL depending on surgical timing. A bump for the foot and lateral post is used so that the knee may be positioned at 90° of flexion (Fig. 7).

Medial Structures

Based on preoperative MRI and EUA, the medial structures of the knee, the MCL, the posterior oblique ligament (POL), and the posteromedial capsule can be assessed. When medial injuries are combined with cruciate injuries, the cruciate ligaments are generally reconstructed first. If the MCL is avulsed off the tibial insertion, it can be repaired (Fig. 8a, b) after the insertion site has been debrided and prepared. For the more common, proximal MCL injuries, repair is often difficult due to poor tissue quality of the proximal MCL (POL) and posteromedial capsule (Potter et al. 2002). In rare cases, these tissues may be advanced and reattached to the femur using suture anchors; however, due to the severity of injury of knee dislocations, a reconstruction is often required.

Fig. 7 Operating room set up for surgical management of knee dislocation

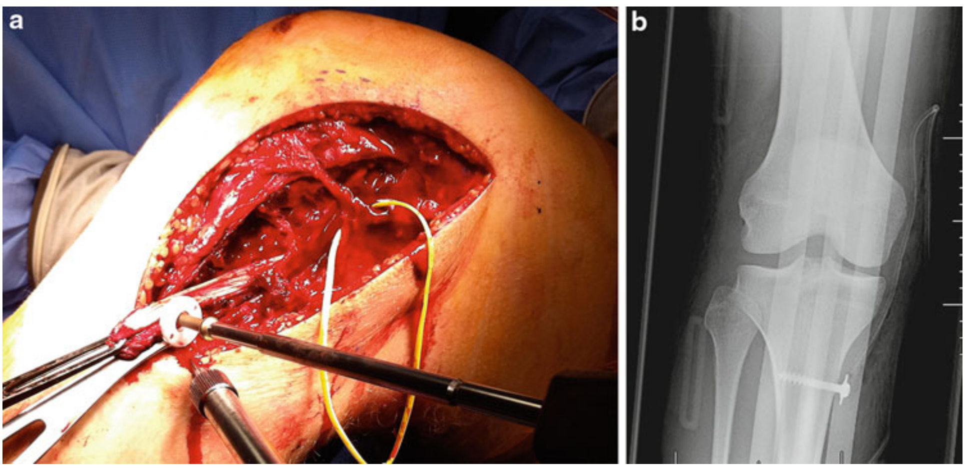

Fig. 8 (**a**) Repair of grade 3 tibial-sided injury using a screw and spiked washer. (**b**) Post-op AP X-ray after MCL tibial-sided repair

The MCL may be reconstructed as described by Bosworth et al. by using the semitendinosus tendon attached at the pes anserinus and dissecting it out proximally. The free end may then be attached to the medial epicondyle of the femur at the isometric point by screw and washer (Bosworth 1952). Despite good historical results with this technique, generally a more anatomical double-bundle MCL reconstruction is preferred (Feeley et al. 2009; Coobs et al. 2010; Lind et al. 2010). The graft is fixed with a staple on the femur and interference screw on the tibia and tensioned with a varus force applied to the knee at 30° of flexion (Fig. 9a, b).

Lateral Structures

A standard lateral hockey stick incision is used to address injuries to the lateral side extending from 5 cm distal to Gerdy's tubercle to 5 cm proximal and posterior to the lateral epicondyle (Terry and LaPrade 1996). Dissection is carried out down to fascia and the peroneal nerve is exposed proximally, outside of the zone of injury, and then carried out from proximal to distal. When intraneural hematoma is found to be compromising nerve function, the epineurium is incised and the hematoma is evacuated.

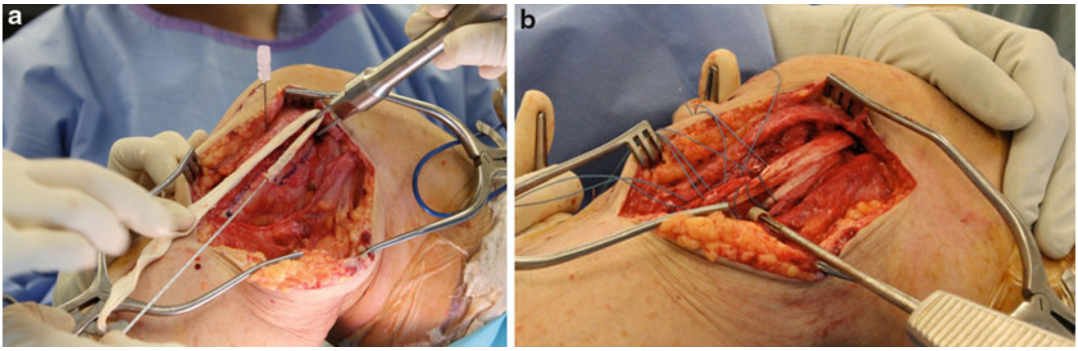

Fig. 9 (**a**) Femoral fixation with stable for double-bundle MCL reconstruction with allograft. (**b**) Tibial-sided fixation for double-bundle MCL reconstruction with allograft

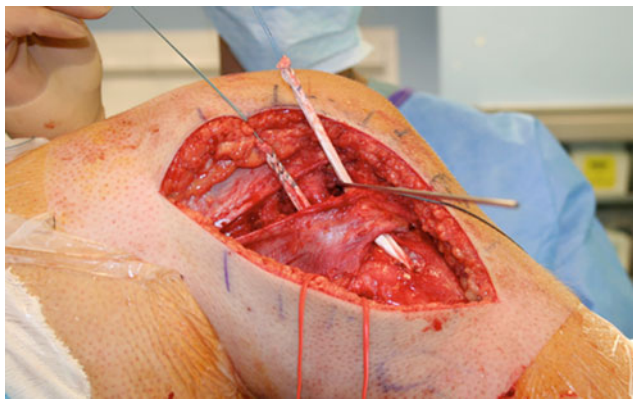

Fig. 10 Fibular-based PLC reconstruction

With direct repair, which is rarely possible, the popliteus is usually addressed first and may be injured at the femoral attachment site or at the musculotendinous junction. If it is injured at the femoral insertion site, it can frequently be advanced and reattached by docking it in a short tunnel or by suture post-fixation. If the popliteus is injured at the musculotendinous junction, it can be tenodesed to the posterolateral corner of the tibia or at the insertion site of the popliteofibular ligament (PFL) on the fibular head, which is just medial and posterior to the insertion of the FCL and biceps tendon (Lunden et al. 2010).

When the posterolateral corner must be reconstructed due to insufficient tissue for repair or time from injury greater than 1 month, a fibular-based technique may be employed (Fig. 10). There are several variations on technique, but the first step is to locate the peroneal nerve posterior and medial to the long head of the biceps tendon. Neurolysis is performed and the nerve is exposed throughout the incision to make sure it is tension-free and that its location is known throughout the case. An allograft tendon may be used to ensure enough length for reconstruction. One 7 mm tunnel is drilled in the fibular head from the FCL attachment on the lateral side to the popliteofibular ligament attachment site on the posteromedial aspect. The graft is passed through the tunnel and the more posterior and medial limb is brought up to the popliteus attachment site on the femur, and the more anterior and lateral limb is brought up to the LCL attachment site on the femur. The two limbs are then docked into short tunnels and may be fixed over the medial side of the distal femur. A two-limbed fibula and tibia-based reconstruction may also be employed as described by LaPrade et al. (2004).

Bi-Cruciate Reconstruction

Arthroscopy is begun in standard fashion with special attention paid to fluid extravasation throughout the procedure. Anatomic single-bundle PCL and ACL reconstructions are performed using an allograft. The PCL is addressed first, and a posterior–medial (PM) portal is created with the use of a spinal needle and the scope may be placed in the anterolateral (AL) or (PM) portals and debridement carried out through the other. A 70° arthroscope is very helpful. The PCL tibial footprint is carefully debrided under direct visualization with care taken to avoid the neurovascular structures; a c-arm may also be utilized. The footprint is visualized in a medial to lateral direction arthroscopically and may be confirmed on the sagittal view with intraoperative fluoroscopy. A tibial PCL guide is placed in the knee and the guide pin advanced carefully under fluoroscopic and arthroscopic visualization towards the tibial attachment site of the PCL, approximately 1.6 mm distal to the proximal joint line (Johannsen et al. 2012; Fig. 11). It is advanced through the posterior cortex by hand and the position is again confirmed with fluoroscopy. The guide pin is over-reamed to the size of the allograft and again advanced through the posterior cortex by hand. The femoral PCL tunnel is then drilled through the low (AL) portal and the scope in the anteromedial (AM) portal (Fig. 12). A double-bundle PCL reconstruction can also be performed using the same AL portal from inside out (Spiridonov et al. 2010). The tibial tunnel for the ACL is then drilled in standard fashion with care taken to avoid the PCL tunnel. The femoral ACL tunnel is drilled using a flexible guide through the (AM) portal at 100° of knee flexion (Fig. 13). The PCL graft is passed through the tibia and pulled up into the femur, followed by passage of the ACL graft. The PCL graft is secured on the femoral side and then secured on the tibial side with the knee at 90° of knee flexion with an anterior drawer applied to the leg. The ACL graft is secured on the femoral side and lastly on the tibial

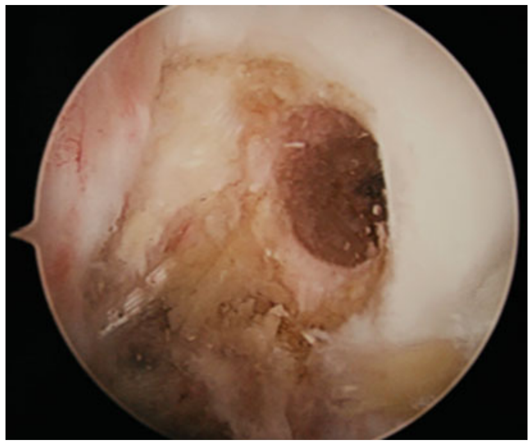

Fig. 12 Femoral PCL tunnel of a right knee viewed from AM portal and drilled through AL portal

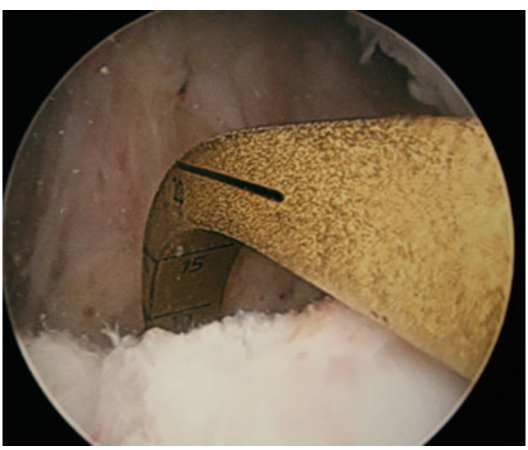

Fig. 11 Tibial PCL guide viewed arthroscopically from the front of the knee

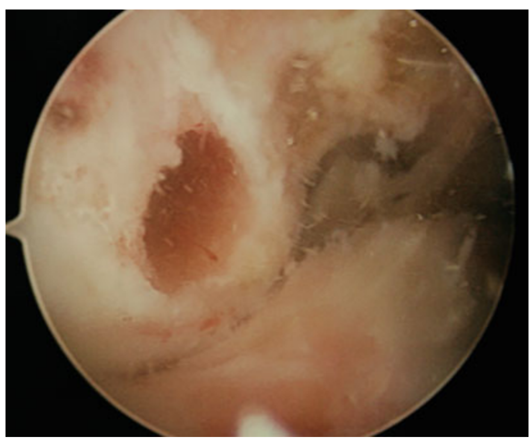

Fig. 13 Femoral ACL tunnel of a right knee drilled with flexible reamer through AM portal, viewed through AL portal

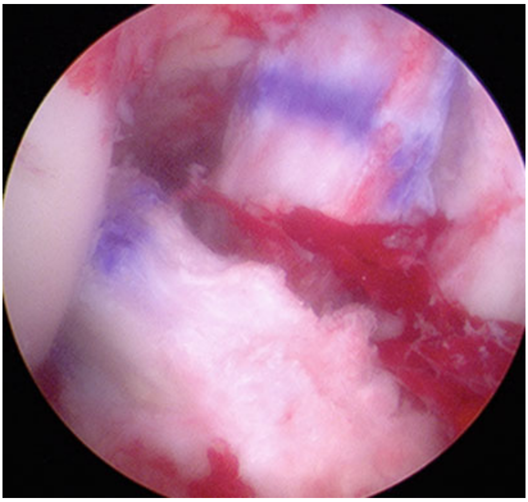

Fig. 14 Arthroscopic picture after right knee bi-cruciate reconstruction

side with the leg in full extension (Fig. 14). The graft may be fixed with graft sutures tied over a screw and washer post. Cortical bone graft can be used in a press-fit fashion to enhance aperture fixation of the grafts. Cortical grafts may be harvested by using core reamers when drilling tunnels or from allograft bone. Examination is immediately performed to assess tension and correction of laxity.

Postoperative

Initial postoperative protocol consists of 6 weeks of non-weight-bearing immobilization with the knee locked in full extension in a knee immobilizer when not undergoing motion in PT. In addition, if available, the use of a PCL jack brace may be initiated at postoperative days 2–3 to allow for early knee motion which protects the PCL reconstruction. The patient is mobilized with physical therapy and quadriceps strengthening is begun immediately. At 6 weeks postoperative, weight bearing is allowed with crutches initially, and the crutches are weaned away over the next few weeks. Active and passive motion exercises are continued during this time. At 6 weeks, extension should be full and flexion should be greater than 90°. From 4 to 6 months, closed-chain strengthening exercises are done progressing to open-chain and straight-line jogging around 6 months. After 6 months the focus is continued strengthening and initiation of functional rehab and activities. Return to play or strenuous work may be considered as early as the seventh month if swelling is absent and strength is 90 % of the contralateral leg. A functional brace may be used for return to sport based on injury.

Conclusions

A knee dislocation is a potentially devastating injury that must be managed appropriately from initial presentation through potentially several interventions and surgeries. A high suspicion for neurovascular injuries should be maintained at all times, and just because one is not obvious at initial presentation does not mean that one has not occurred. Surgical management should be well thought out and planned because complications such as wound problems, compartment syndrome, neurovascular injury, and stiffness are more common than in less severe extremity injuries.

Cross-References

▶ Acute Posterior Dislocations and Posterior Fracture–Dislocations of the Shoulder
▶ Allografts in Anterior Cruciate Ligament Reconstruction
▶ Allografts in Posterior Cruciate Ligament Reconstructions
▶ Anterior Cruciate Ligament Injuries and Surgery: Current Evidence and Modern Development
▶ Combined Anterior and Posterior Cruciate Ligament Injuries
▶ Different Techniques of Anterior Cruciate Ligament Reconstruction: Guidelines
▶ On-the-Field Management of American Football Injuries
▶ Personalized Treatment Algorithms for Anterior Cruciate Ligament Injuries
▶ Rehabilitation of Complex Knee Injuries and Key Points

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