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A Review of Knee Dislocations

Andrew Henrichs

Valley View Hospital Rehabilitation Services, Glenwood Springs, CO

Andrew Henrichs, ATC, provided conception and design and drafting, critical revision, and final approval of the article.
Address correspondence to Andrew Henrichs, ATC, Valley View Hospital Rehabilitation Services, 1906 Blake Avenue, Glenwood Springs, CO 81601. Address e-mail to a_henrichs@yahoo.com.

Objective: To inform health care professionals about the various mechanisms of this little-known injury, as well as its potentially limb-threatening complications. In addition, keys to immediate recognition and the importance of a thorough rehabilitation program are stressed.

Data Sources: I searched MEDLINE (1966–2000) using the key words *knee dislocation, knee injury,* and *tibiofemoral dislocation.*

Data Synthesis: Knee dislocations are uncommon but very serious injuries. Because the joint may spontaneously reduce before the examiner reaches the patient, the examiner must be aware of the potential complications and rule out any neurovascular damage immediately.

Conclusions/Recommendations: Prompt recognition of this injury and proper care combined with an extensive rehabilitation program can greatly improve the prognosis for the patient. Neurovascular integrity should be assessed routinely for several days after the injury to ensure that complications do not develop.

Key Words: tibiofemoral joint, rehabilitation, knee injury

Knee dislocations are an extremely traumatic injury and can be limb threatening. Because of the potential neurovascular damage associated with this injury, knee dislocations are considered one of the most serious knee injuries, albeit one of the most rare. Due to spontaneous reductions, the true frequency of knee dislocations is not known.[1–4] Unreduced dislocations present with an obvious deformity, but spontaneously reduced dislocations can lead the examiner to underestimate the severity of the injury, thereby risking the limb.[1–3,5,6] After suffering a knee dislocation, the patient is faced with a long and difficult rehabilitation program, which must focus on full range of motion (ROM) and strength in order to achieve functional recovery.[5,7–9]

Anatomy

The knee complex is stabilized by 6 main ligamentous or cartilaginous structures as well as several muscles and tendons. Anterior and posterior tibial translations are prevented by the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL), respectively.[2,10–12] Excessive valgus forces are restrained by the medial collateral ligament (MCL), whereas excessive varus forces are restrained by the lateral collateral ligament (LCL).[2,13] The medial and lateral menisci transmit axial loads and stabilize against any rotational forces.[2] The muscles and tendons that aid in stabilizing the knee include the vastus lateralis, vastus medialis, vastus intermedius, rectus femoris, biceps femoris, semitendinosus, semimembranosus, sartorius, gracilis, iliotibial tract, popliteus, and gastrocnemius.

The popliteal artery attaches proximally to the adductor hiatus and distally to the fibrous arch of the soleus muscle.[1,2,7,10] Inside the popliteal fossa, the popliteal artery gives off 5 genicular arteries[1,2,4,12]: paired superior and paired inferior arteries and the middle genicular artery.[14,15] Also supplying collateral circulation to the knee are the lateral femoral circumflex and anterior tibial arteries.[2] Despite the apparent abundance of collateral blood supply, these genicular arteries cannot compensate for a ruptured popliteal artery.[1,2,10,14,16] The tibial nerve joins the popliteal artery in the popliteal fossa but is not tethered to the knee. The peroneal nerve passes around the proximal fibula just distal to the fibular head.[1,2,4,10,12,16]

Mechanism of Injury

Knee dislocations are typically classified in terms of tibial displacement with respect to the femur.[2,3,12,13] Knee dislocations occur in 5 main types: anterior, posterior, medial, lateral, and rotary.[2–4,7,17,18] Rotary dislocations can further be divided into anteromedial, anterolateral, posteromedial, and posterolateral injuries.[3,7,10,12,13] Posterolateral dislocations are considered to be very difficult, if not impossible, to reduce by closed methods.[7,19–21] Although the mechanism varies for each classification of knee dislocation, most involve significant forces delivered in a violent manner to the knee.

Knee dislocations can be further divided into high-velocity and low-velocity categories.[8] High-velocity dislocations are generally caused by a sudden, extremely violent force, such as a car accident.[2] High-velocity dislocations result in vast damage to the structures of the knee complex, including disruption of soft tissues such as the joint capsule, popliteal tendon, menisci, and cartilage.[7,8,16] They are also more likely to involve neurovascular damage. Low-velocity knee dislocations generally occur in sports settings and are the type typically seen by athletic trainers. Low-velocity knee dislocations are typically associated with lower rates of neurovascular and associated soft-tissue damage.[2,8] Because of the less extensive associated damage, low-velocity knee dislocations generally have a better prognosis than high-velocity knee dislocations.[8]

The most common mechanism of injury (MOI) for an anterior dislocation is forced hyperextension.[2,10,17,22,23] This hyperextension commonly occurs in motor vehicle accidents[1,8,13] but can also occur during collisions in sports such as foot-

ball,[11,24] rugby, or soccer[13] or by simply stepping into a hole.[8,11,13,19,22] Kennedy[22] has shown in cadaver experiments that the posterior capsule ruptures at approximately 30° of hyperextension, followed shortly by rupture of the PCL and the resulting forward displacement of the tibia. Morbid obesity is one potential risk factor for both anterior and posterior dislocations due to the tremendous stresses placed on the stabilizing muscles and joints during movement. Because forces ranging from 2 to 4 times body weight are experienced during certain stages of ambulation, the MOI for a morbidly obese patient can be as simple as ambulating or rising from a seated position.[25]

The most common MOI for a posterior knee dislocation is a direct force on the tibia while the knee is flexed, forcing the tibia posteriorly on the femur.[2,11,16,17,26,27] This mechanism primarily occurs when the tibia strikes the dashboard[2,10,26] or when a runner falls on a flexed knee.[2,26] Other, less common mechanisms for a posterior knee dislocation include a direct blow to the knee[16,24] and stepping into a hole.[8,19,28]

The MOIs for medial and lateral knee dislocations are generally varus or valgus forces.[2,7,10,16,17] Rotary knee dislocations are produced by rotary forces.[16] The irreducible posterolateral dislocation is produced by valgus stress combined with internal tibial rotation delivered to a flexed, nonweightbearing knee.[17,19,21] This causes the medial femoral condyle to buttonhole through the anteromedial capsule.[2,17]

Initial Assessment

Recognition is the single most important aspect of dealing with a knee dislocation. If the knee dislocation spontaneously reduces before the examiner reaches the patient, it can be easy to underestimate the severity of the injury.[3] A spontaneously reduced knee dislocation can cause the examiner to overlook vital neurovascular clues that could determine the viability of the limb.

In any instance in which a knee dislocation is suspected, neurovascular assessment should immediately become the focus of the evaluation. If deemed safe, the shoes should be carefully removed to allow a more accurate neurovascular assessment. The evaluation should be very thorough, and any discrepancies should be noted. It is absolutely vital to immediately assess and compare the posterior tibial and dorsal pedal pulses. The assessment should also include bilateral comparison of dermatomes, myotomes, capillary refill, skin color, and skin temperature.[3,4,26,29]

Typically, the patient complains of severe pain and instability and is unable to continue with sports or activities of daily living.[13] A patient with an unreduced knee dislocation presents with an obvious visible and palpable deformity.[16] The patient often hears a pop at the time of injury.[13] Pain tends to be diffuse with palpation, and knee ROMs are limited.[30] Strength testing should not be attempted due to the substantial ligamentous and soft tissue damage sustained during the injury. The Lachman and pivot-shift tests should be performed to test for ACL injury, whereas the posterior drawer[26,30] and posterior sag tests[3] should be carried out to test PCL integrity. Valgus and varus stress tests should be conducted to assess damage to the MCL[3,30] and LCL,[3] respectively.

The exact amount of ligamentous damage necessary to dislocate the knee is disputed.[17] Although the conventional thinking is that both cruciate ligaments and at least 1 collateral ligament must be torn in order for the knee to dislocate,[11,13,19] some patients who have suffered a knee dislocation still have 1 cruciate intact.[2,7,15,21,22,31] It is advisable to treat any patient presenting with significant valgus or varus instability in full extension,[2] complete disruption of 2 or more ligaments,[3,8,26] or exaggerated hyperextension (indicative of combined cruciate disruption[1]) as a possible knee dislocation.

Keys to Evaluation

Damage to the neurovascular system is one of the greatest concerns when dealing with a knee dislocation. The lack of swelling and effusion in knee dislocations is relatively insignificant because of capsular damage and fluid extravasation, which may cause circulatory damage to go undetected and, therefore, untreated.[1,13,16] Patients have been reported to sustain a knee dislocation and yet have a warm foot[3,14,16,20,22] or palpable dorsal or pedal pulses[2,7,32,33] despite popliteal artery damage. As a result, many experts are in favor of performing arteriograms with any significant injury to the knee in order to rule out arterial damage.[2,4,5,17,26] The popliteal artery, because of its attachments both proximal and distal to the knee, is injured in approximately 20% to 40% of all knee dislocations.[6,12,13] Vascular damage is most common in anterior and posterior dislocations.[3]

Although the peroneal nerve is not tethered to the knee, it can still be injured due to its anatomical location as it passes around the fibular neck.[4,10,12,24] Peroneal nerve injury has been shown to occur in up to 33% of knee dislocations,[12,13,20] but it is most common in anterior, posterolateral, and medial dislocations.[17]

Treatment

The initial treatment for either a spontaneously reduced or an unreduced dislocation is immediate splinting of the knee in extension or the most comfortable position and immediate transport to the nearest emergency room.[2] Once the patient has reached the emergency room, the dislocation should be reduced immediately and the neurovascular status reassessed.[2,4,7,16,26] Closed reduction is preferred,[11,16,18,22,26] although in cases such as a posterolateral dislocation, open reduction may be necessary.[15,18,21,22] Postreduction, the preferred treatment can vary.[4,7,8,30,34]

Conservative treatment is often chosen if the joint feels relatively stable postreduction[4] or if the patient is either older or sedentary with intact collateral ligaments.[2] Conservative treatment generally consists of immobilization[5,30,34–36] ranging from 3 to 10 weeks, with 5.5 weeks the average length of time. Currently, immobilization longer than 6 weeks is not recommended due to residual stiffness.[27] Although conservative treatment can result in a stable knee, stiffness and dysfunction commonly result.[7] Conservative treatment is, therefore, typically considered unsuitable for young, active, athletic populations.

Surgical treatment has proved to be much more beneficial for active patients, particularly with recent advances in surgical techniques.[2,7,8,16,26,37] Surgical treatment depends on which ligaments were injured and the severity of injury to those ligaments.[4] Grade III ligamentous injuries are nearly always reconstructed or repaired, whereas grade I and II ligamentous injuries typically do not mandate either repair or reconstruction. The question of repair versus reconstruction of grade III ligamentous injuries is usually determined by mag-

netic resonance imaging findings, but the choice can be made during arthroscopy.[7] Generally, midsubstance tears are reconstructed and avulsed ligaments are repaired.[9] Repairs are often not as strong as reconstructions and are, therefore, less favored in treating knee dislocations.[7] Allografts tend to be the preferred graft for use in the surgical reconstruction of knee dislocations because graft site morbidity is eliminated and the number of incisions, tourniquet time, and postoperative pain and stiffness are decreased.[7,9,26]

Rehabilitation

Rehabilitation after a knee dislocation is dictated by both the specific ligaments injured and the method of treatment. Regardless, a patient who sustains a knee dislocation is faced with a long and arduous rehabilitation program, with return to full activity taking at least 9 to 12 months.[13,26] Even with a comprehensive rehabilitation program, it is unlikely that the athlete who suffers a knee dislocation will be able to compete at the same level as before the injury.[8]

Conservative treatment allows limited rehabilitation to begin immediately. Upper and midbody exercises are started, along with single-leg stationary bicycling in order to maintain cardiovascular conditioning. Quadriceps strengthening is emphasized in order to prevent patellofemoral problems throughout the rehabilitation process. Range of motion should be limited from 90° of flexion to 45° of extension by a brace during early exercises in order to decrease the stretch on the healing knee ligaments. Light manual-resistance exercises may be performed in this range as tolerated. These exercises should be performed in the midranges of speed and resistance; as the pain decreases, the speed and resistance should be increased. As the patient progresses, other resistance machines such as Cybex (Cybex International, Inc, Medway, MA), Biodex (Biodex Medical Systems, Shirley, NY), or Nautilus (Nautilus, Inc, Vancouver, WA) may be used in place of manual therapy.[38]

At approximately 8 weeks postinjury, the knee needs only minimal protection and the patient may begin using a leg-press machine. Swimming and stationary bicycling using both legs can also start at this time, as can exercises aimed at increasing endurance, such as 3 sets of 100 quarter squats. These activities should be followed by high-speed exercises with light resistance, such as knee extensions and flexions with resistance tubing. Supplemental exercises such as jogging and moderate stationary bicycling are extremely beneficial during this period. Finally, proprioception can be regained through exercises such as trampolines, agility drills, and tilt boards.[38] Once sufficient ROM and strength have been regained and the athlete has successfully performed functional testing, he or she may return to activity, which is typically limited to activities of daily living and light work.[26,30,38]

In patients who undergo ligamentous repair, surgery is typically performed 1 to 3 weeks postinjury in order to allow the acute inflammatory phase to subside.[7,26] This delay often results in a decreased likelihood of postoperative stiffness.[26] During the time between the injury and surgery, the knee should be placed in a brace[4,7,26] and rehabilitation should include straight-leg raises, electric muscle stimulation, and short arcs of motion. Ice and elevation should also be used. No vigorous quadriceps or hamstring strengthening exercises should be performed during this time in order to prevent further exacerbation of the injury.[4]

Postsurgical rehabilitation for this injury varies according to which ligaments were injured and repaired. Initially, a long-leg brace with limits of 40° of extension and 70° of flexion should be worn if a continuous passive-motion machine is used.[38] These limits prevent any undesirable strains on the repaired ligaments. Quadriceps setting is implemented immediately to increase quadriceps control. Straight-leg raises are also begun at this time, but the brace should initially be locked in full extension in order to eliminate tibial lag.[7,16,38] Once the patient has adequate control of the leg, ambulation is allowed. Crutches should be used for ambulation during these first 6 weeks, but early weightbearing is encouraged. Full extension is a primary goal during the first postoperative week.[8] This can be accomplished with therapeutic exercises, such as prone hangs and quadriceps sets. Other appropriate strengthening activities include hamstring sets, short-arc quadriceps exercises with the brace unlocked,[36] and light manual resistive exercises.[7,16,38] Cardiovascular exercise during this period is very important but is largely limited to the use of an upper body ergometer.

From weeks 7 to 10, the brace is unlocked and ROM therapy emphasizing full flexion and extension is begun, progressing to full weightbearing with crutches.[7,9,26,38] Stationary bicycling allows the patient to improve ROM while minimizing stresses placed on the joint.[16,38] Strengthening exercises such as quadriceps sets, hamstring sets, short-arc quadriceps exercises, and manual resistive exercises should be continued during this time. Once the patient bears full weight and gains good control of the injured leg, crutches are discontinued.[26] From weeks 11 to 24, ROM therapy progresses, as the patient should have near full flexion and extension. Initial strength training is begun using closed kinetic chain exercises such as quarter squats, light leg presses, terminal knee extensions, step downs, and step ups.[26] Strength training at this time should be done in a limited ROM to minimize strain on the repaired structures.[16] Open kinetic chain exercises such as side-lying hip adduction and abduction, prone hip extension, prone knee flexion with the brace on but unlocked, supine hip flexion, and seated internal and external hip rotation may be performed, provided the collateral ligaments are intact. If the collateral ligaments are damaged, these exercises may be performed with the brace on and locked. Cardiovascular exercise during this period can include stationary bicycling as well as upper body ergometer work.

Strength training continues through weeks 25 to 36, becoming more advanced as the patient progresses.[26] Advanced exercises may include full squats with weight, knee flexion, dead lifts, and the 4-way hip machine with the pad located proximal to the knee. As the patient reestablishes bulk and strength around the knee, proprioceptive exercises such as balance boards or trampolines are integrated.[16] Once proprioceptive exercises are implemented, they should be stressed in the rehabilitation program. The patient should progress from standing on a stable surface with eyes open to an unstable surface to eyes closed. The patient may also cross the arms across the chest to increase the difficulty. Once strength and ROM are reestablished, typically around 6 months, other athletic activities such as running can begin.[16,38] When the patient begins running, running up stairs is ideal; this minimizes the strain on the repaired ligaments. Downhill running should be avoided for 6 to 12 months due to significant strain on the ACL.[16] This final stage of rehabilitation consists of a significant amount of sport-specific exercises. The athletic trainer should

take into consideration both the sport and position when determining which sport-specific exercises should be performed. After week 37, if adequate ROM and strength are recovered and functional tests are passed, the patient is allowed to return to sports and heavy work.[26,30,38] Use of a brace can be discontinued after 48 to 72 weeks postsurgery, depending on the patient's progress.[13,16,38]

Complications

Because of the violent nature of this injury, many serious complications can ensue. Perhaps the most serious complication results from the high incidence of vascular injury. If vascular insufficiency is left untreated for more than 8 hours, the chance of amputation is 86%, compared with an 11% chance if treated within 8 hours.[14] Deep venous thrombosis has also been associated with knee dislocations.[1,26,36,39] A venogram is often recommended to rule out deep venous thrombosis.[35]

Knee dislocations are often complicated by acute compartment syndrome, which necessitates a fasciotomy.[1,5,7,24,39] Athletic trainers should note any painful passive muscle stretch, swelling, or hyperesthesia as possible signs of compartment syndrome.[1] Although compartment syndrome may not be present initially, it is vital to monitor the status of the leg, as the condition may develop over time. The threat of these potential complications makes it necessary to constantly and carefully monitor the neurovascular status of the patient.[10] Posttreatment complications tend to involve persistent instability,[40] posttraumatic arthritis,[12] and loss of motion.[1,7–9,26]

Prognosis

The prognosis for patients who have sustained knee dislocations depends on the velocity of the injury,[8] the amount of neurovascular damage,[15] the treatment method, and the dedication to the rehabilitation program.[4] The velocity of the dislocation plays a crucial role in the prognosis. Because high-velocity knee dislocations are associated with more extensive damage, it is unlikely that athletes who suffer these injuries will return to their original level of competition.[40] In contrast, low-velocity knee dislocations have a relatively good prognosis. Shelbourne et al[8] reported that 77% of patients who sustained low-velocity knee dislocations returned to some type of sport, and 19% returned to their previous level of competition. Some athletes have returned to full activity,[15,37,40] although the velocity of the dislocation was unspecified.

If arterial damage is repaired in a timely manner, the prognosis is generally good.[4,12,14,41] However, if the peroneal nerve is injured, the likelihood of a return to full activity is poor.[2,4,10,12,41] The choice of treatment method has an immense effect on the prognosis.[4] Although conservative treatment can yield good results, these results are generally unacceptable for athletes or high-demand patients wishing to return to full activity. Very good to excellent functional recovery is unlikely unless surgical repair is performed.[11]

Knee dislocations are uncommon injuries with very serious complications. Due to the low incidence of this injury, relatively few comprehensive studies on knee dislocations are available. The inconsistency of treatment methods also makes it difficult to select the best method, although surgical repair has recently become the preferred treatment.

It is vital that certified athletic trainers recognize the signs of a spontaneously reduced dislocation, immediately assess the neurovascular integrity of the limb, and carefully splint the limb for transport. Once the ligaments are repaired, the certified athletic trainer can play a significant role in the patient's recovery. A comprehensive rehabilitation program tailored to the patient must be implemented as soon as possible. If neurovascular damage is limited and the rehabilitation program is followed, the prognosis for a return to full activity is generally good.

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