The Dislocated Knee

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Abstract

Knee dislocation, although relatively rare, may be the result of high- or low-velocity injuries. Well established is the need for urgent diagnosis and treatment to avoid vascular complications and amputation. The initial evaluation should include objective assessment of arterial circulation by means of Doppler pressure measurements; the finding of any asymmetric pressure warrants an arteriogram. Late arterial occlusion may occur, which mandates careful serial reexamination in all patients, including those with initially symmetric pressure. Injury to the peroneal nerve is also common, and the recovery of neurologic function is unpredictable. An operative approach for the young and otherwise healthy patient is outlined. In the absence of definitive clinical studies, the timing and extent of the repair/reconstruction and the optimum rehabilitation still remain uncertain. Therefore, individual patient management must be dictated by circumstances such as instability, swelling, activity level, and the risk of postoperative joint stiffness.

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The first written reports of dislocation of the knee appeared more than a hundred years ago, when the injury was described as very rare. The diagnosis was confined to those cases in which dislocation was obvious at the scene of an accident or when the patient arrived at a hospital. Vascular and nerve injuries were found to be frequently associated with the injury; any outcome other than amputation was considered a success, even if the result was a completely stiff knee.

Since these early publications, reported incidence rates have varied, being calculated largely on the basis of admission rates to hospitals without the population at risk being known. Representative data are as follows: only 14 cases of knee dislocation out of 2 million admissions during a 50-year period at the Mayo Clinic1; 6 dislocations out of 48,000 bone and joint injuries at a regional center in England[2]; 26 patients with knee dislocation admitted to the Massachusetts General Hospital during a 28-year period[3]; and 53 cases at the Los Angeles County Hospital during a 10-year period.[4] Knee dislocation is still uncommon today, but the incidence is probably rising due to the increased general speed of vehicles, the large number of people participating in sports, and better recognition of the entity.

Anatomy

Joint stability and normal knee kinematics are maintained by the shape of the femoral and tibial condyles and the menisci in combination with the passive supporting structures, the most obvious ones being the four major ligaments—the anterior cruciate ligament (ACL), the posterior cruciate ligament (PCL), the medial collateral ligament (MCL), and the lateral collateral ligament (LCL). To these factors must be added the significant contribution by the posteromedial and posterolateral capsular components and the iliotibial tract. A large contribution to the functional stability is also made by the dynamic stabilizers—the muscles acting over and inserting in proximity to the joint.

In the popliteal fossa, separated from the posterior joint capsule by a layer of fat, run the popliteal artery and vein (Fig. 1). The artery is tethered proximally by the adductor hiatus and distally by the soleus arch, where it normally bifurcates into the anterior and posterior tibial arteries. The genicular arteries originate within the popliteal fossa and give rise to the collateral circulation around the joint. This collateral circulation is insufficient to maintain

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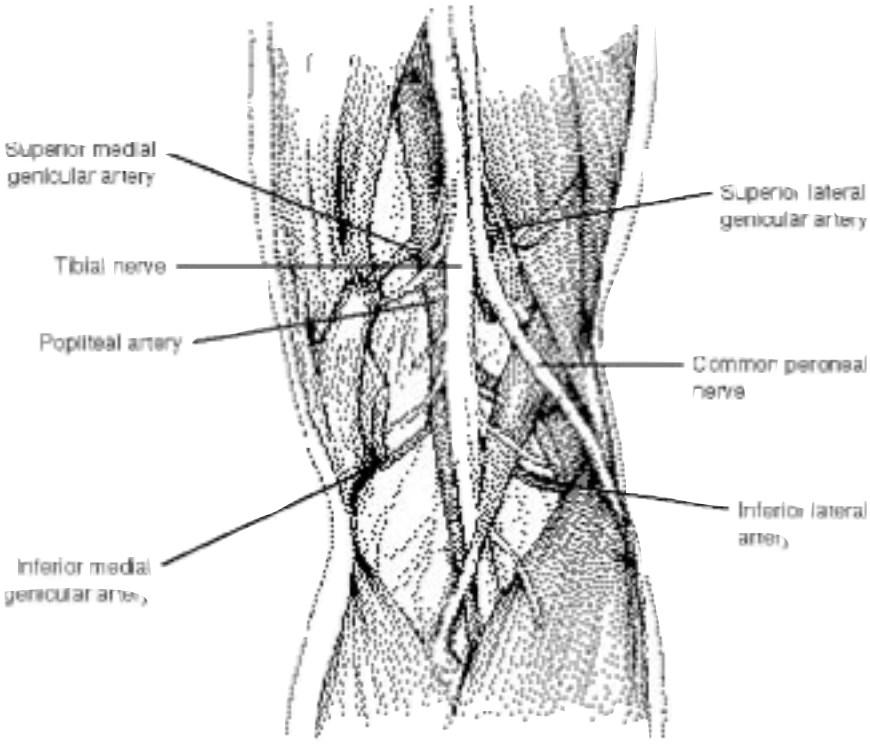

Fig. 1 Neurovascular anatomy of the posterior aspect of the knee. Due to their position, the popliteal artery and the peroneal nerve are particularly vulnerable to injury with posterior dislocation of the knee.

the viability of the leg if the popliteal artery is transected or obstructed.[5]

The tibial and common fibular nerves run superficial to the constraining adductor hiatus, and only the tibial nerve is routed deep to the soleus arch, possibly leaving the neural structures less vulnerable to injury than the artery when the knee is dislocated.

Classification

Currently used classification schemes are based on the following variables: (1) the direction of displacement; (2) whether the dislocation is confirmed complete or presumed complete; (3) whether the injury is open or closed; or (4) whether the injury was caused by high-energy trauma or low-energy trauma. Each method has certain advantages in predicting neurologic, vascular, and infection risk. An appropriate description of the dislocated knee should therefore include elements of all these systems in order to obtain the best possible guide for diagnosis and treatment as well as a prediction of the prognosis.

In addition to the four major directions of dislocation (i.e., anterior, posterior, medial, and lateral), combinations of these can be present. The relative incidence of the directionally classified dislocations varies considerably between published reports, but most authors agree that the anterior dislocation is the most common, closely followed by the posterior. The most frequently described combination is the posterolateral dislocation, which includes an internal rotatory component, in which the medial femoral condyle has "buttonholed" the anteromedial capsule. This injury often is irreducible, which usually is evidenced by a transverse groove in the skin at the medial joint line caused by the invagination of parts of the medial capsule. The furrowing of the skin becomes even more prominent as reduction is attempted. This phenomenon has been called the "dimple sign," and is believed to be pathognomonic of the irreducible posterolateral dislocation.

The traditional classification by direction does not take into consideration the possibility that a knee may have been instantaneously dislocated and then spontaneously reduced. Today it is widely accepted that any patient in whom three or more of the major ligaments have been torn should be regarded as having potentially sustained a knee dislocation. This definition has previously been used in the literature,[6] and the high incidence of vascular and/or nerve injuries in association with multiple ligament injury without apparent dislocation has also been emphasized.[7] However, the often-used term "complete dislocation" is a source of ambiguity since this condition has not been clearly separated from subluxations or angular deformities.

Whether the injury is open or closed constitutes an additional basis for classification. Open dislocations are not infrequent. Shields et al[3] found that 9 of 26 (35%) of their patients had open injuries, as did 10 of 53 (19%) of the patients of Meyers et al.[8] Their observations indicate that posterior and anterior dislocations are more apt to be open than dislocations in other directions.

A distinction has also been made between low-velocity injuries, usually related to sports, and high-velocity injuries, which are most often caused by motor-vehicle acci-

dents or falls from a great height. A lower incidence of associated vascular compromise has been reported for low-velocity dislocations.[6] The often covert nature of vascular injuries associated with low-velocity dislocations also has been emphasized to make the point that vigilance for these devastating injuries is essential.[9] The clinical relevance of a distinction between high- and low-velocity dislocations cannot be fully appreciated until further epidemiologic studies have been conducted to evaluate the occurrence and severity of soft-tissue trauma, vascular compromise, and concomitant fractures.

Mechanism of Injury

The only published experimental study that analyzed the mechanism of injury of knee dislocation was done by Kennedy[10] in 1963. He was invariably able to produce anterior dislocations by hyperextending knee specimens, establishing that the dislocation was preceded by rupture of the posterior capsule and the cruciate ligaments. However, he found that posterior dislocations were difficult to produce in the laboratory and required high torque. It is now believed that these injuries result from a posteriorly directed blow to the proximal tibia,[11] a mechanism that Kennedy's experiments were unlikely to produce.

Medial and lateral dislocations are less common than those in anterior or posterior directions. In Kennedy's study, medial and lateral dislocations were the result of "extreme forces," usually pure varus or valgus rotatory moments of the lower leg, which are most likely to occur in high-energy accidents.[10] Although very modest injuries, such as those due to slipping off a curb or tripping in a hole, may result in a knee dislocation, more than 50% of the classified knee dislocations that have been reported were caused by motor-vehicle accidents.[3,11,12]

Quinlan and Sharrard[2] proposed a mechanism of injury for the irreducible posterolateral dislocation, which has gained general acceptance. This involves a flexed knee, a non-weight-bearing situation, and a sudden rotatory moment that both abducts and medially (internally) rotates the lower leg on the femur.

Associated Injuries

Ligament Injuries

Dislocation of the knee invariably results in rupture of several major knee ligaments. Kennedy[10] found experimentally and clinically that the ACL was not always torn completely. Kennedy and later Shields et al[3] reported that the collateral ligaments often were only stretched in anterior and posterior dislocations. Meyers et al[8] reported five cases of intact PCL following knee dislocation, and Shields et al[3] reported several instances in which only the corresponding cruciate was torn with anterior and posterior dislocation. The opinion that both collateral ligaments can be macroscopically intact is not very controversial as long as the dislocation occurs in the sagittal plane, but several authors question the possibility of either of the cruciates being left intact.[11,13]

We propose that a ligament should be considered disrupted once a grade III or IV laxity has been established according to the International Knee Documentation Committee definition, specifically, more than 6 mm of joint opening or translation compared with the noninjured knee. Grossly abnormal laxity is obvious during manual examination, but in some cases with subtle changes in laxity, objective arthrometric measurement or stress radiography may be required to achieve correct grading.

Many knee dislocations not only involve the ACL, PCL, MCL, and LCL but also result in extensive capsular damage and rupture of the menisci or muscles and tendons adjacent to the joint.

Vascular Injuries

The popliteal artery is especially vulnerable due to its limited mobility. Two major types of injury mechanisms are described. One involves stretching of the artery, which is common with anterior dislocations. The other is a direct contusion of the vessel by the posterior rim of the tibial plateau, most often seen with posterior dislocations. Total vessel rupture as well as damage restricted to the intima can result from both anterior and posterior dislocations.[3,5,10,14-18] Arterial spasm is not an appropriate diagnosis[9,16,17] and should under no circumstances be blamed for poor circulation in the leg. What might be suspected to be a spasm is usually intimal damage and is followed by a high risk of subsequent thrombosis formation.[5,16-18]

The incidence of vascular compromise was estimated to be 32% by Green and Allen[19] in an extensive review of the literature on knee dislocations. The highest risk occurs with anterior and posterior dislocations; approximately 40% of cases are accompanied by arterial injury.[19] Vascular injury and even total disruption of the popliteal artery are described in knee trauma resulting in multidirectional instability without an apparent frank dislocation.[7] Injury to either of the tibial arteries has been described both in conjunction with compromise of the popliteal artery[17] and as an isolated finding.[9]

Nerve Injuries

The reported incidence of nerve injury in cases with verified dislocation of the knee is extremely variable, but a reasonable approximation is 25%.[3,8,10,12,13,20,21] The majority of cases

involve the common peroneal nerve (Fig. 1) and are usually associated with lateral, medial, and rotatory dislocations. However, in the large series of Meyers et al,[8] 9 of 14 nerve injuries in 53 patients were associated with anterior and posterior dislocations. Injuries to the tibial nerve have also been described.[22]

Fractures

The incidence of any fracture may be as high as 60%[8] because of the frequent association of knee dislocations with multiple trauma. In the region of the knee, tibial plateau fractures and smaller avulsed or sheared-off bone fragments from the proximal tibia or distal femur are commonly seen.[4,8,13,21] No reliable estimate of the incidence of these minor bone lesions can be made on the basis of the literature, but a high association with medial and lateral dislocations has been suggested.[9]

Occasionally, unstable tibial plateau fractures are included in the classification of knee dislocation.[8] Moore[23] defined an entity called "fracture-dislocation" in order to avoid confusing terminology. He distinguished fracture-dislocations from plateau fractures and knee dislocations because of different treatment requirements. Fracture-dislocations are often comminuted tibial plateau fractures associated with capsular or ligamentous disruption, which separates them from pure fractures of the tibial plateau. Like pure knee dislocations, they result in marked joint instability and are associated with a high risk of soft-tissue and neurovascular complications. Fracture-dislocations often require both bone stabilization and soft-tissue repair to achieve joint stability, as opposed to plateau fractures, which are mainly dependent on bone fixation, and pure knee dislocations, which require only soft-tissue repair.[23] Not only is the entity fracture-dislocation conceptually midway between plateau fracture and knee dislocation, but the long-term prognosis is also intermediate, with plateau fractures doing best and dislocations worst.[23]

Evaluation and Early Management

General Considerations

The diagnosis is usually not difficult when knee dislocation is present on the initial examination. The severity of the symptoms should lead to radiologic examination (Fig. 2) even in patients without gross malalignment or swelling, which may be absent with rotatory dislocations. The presence of a dimple sign, indicating posterolateral dislocation, should always be sought. Extensive soft-tissue injury and gross ligamentous instability imply spontaneously reduced dislocations and should mandate further investigation. Patients who have sustained multiple trauma may have unrecognized knee dislocations, because the focus of attention at admission to the hospital is on the more obvious and sometimes life-threatening injuries.

Fig. 2 Lateral view of a typical anterior dislocation of the knee.

The neurovascular status must be immediately assessed. In the presence of a vascular injury, with its associated sensory and motor dysfunction, it is sometimes difficult to establish the true extent of the neurologic component of the injury. This differentiation is not critical initially, because the outcome of a nerve injury is not dependent on rapid therapy, but repeat examinations are necessary for several days after the injury.

Reduction

If at all possible, a dislocation evident at the time of initial examination should be reduced immediately, preferably in the emergency room. Reduction is often accomplished without general anesthesia, but usually requires intravenous administration of adjuvant drugs. Traction is applied to the tibia, and the proximal tibia is manipulated appropriately, depending on the direction of dislocation. Reevaluation of joint congruence and circulation status must follow reduction.

The presence of a dimple sign, indicating a posterolateral dislocation, contraindicates an attempt at closed reduction. Such a dislocation with interposition of the medial joint capsule must be reduced operatively[2,24] because of the high risk of skin necrosis.[24]

Vascular Injuries

The obvious sign of impaired circulation is absence of palpable pedal pulses. Cyanosis or pallor, weak capillary refill (taking more than 3 seconds), and decreased peripheral temperature are strong warning signals, but the absence of these signs does not exclude arterial occlusion.[16,17] Significant vascular dam-

age in spite of palpable pedal pulses has frequently been reported.[5,9,18,20] Doppler pressure measurement is a more accurate method of assessment, which has been shown to correlate well with arteriographic findings[7] and is essential in all cases of persistent or suspected antecedent knee dislocation. The ankle-brachial pressure ratio is a widely used method of normalizing the Doppler pressure value. If this is reduced below what is considered a normal value of less than 0.8, an arteriogram is required. Compromised circulation should under no circumstances be explained as being due to arterial spasm; such an assumption may lead to irreversible damage.

In the case of symmetric pulses, verified by Doppler pressure measurement, the most severe arterial injury involves intimal damage. Currently, not all intimal flaps are being repaired by vascular surgeons, and an arteriogram would not change the treatment course in the face of symmetric pressure.

In cases in which arterial damage is strongly suspected on the basis of asymmetric pulses or pressure, arteriography is preferably performed in the operating room in order to avoid delay of correction of the vascular compromise (Fig. 3). Unfortunately, arteriograms may give equivocal information, especially the "one shot" procedure often performed on the operating table, which is not as good as the biplane, sequential, and often digitally subtracted films that can be obtained in an angiographic laboratory. Films of lesser quality are often a necessary trade-off, since time is a crucial factor. If the arteriographic findings are equivocal and the clinical level of suspicion is high, exploration of the popliteal artery should be strongly considered, as this is preferred to attending to a vascular lesion too late. Preoperative arteriography is also advocated by some in patients who have clinically obvious occlusion or disruption, in order to facilitate vascular reconstruction.[7,15] Others argue that little is gained by this approach.[19] Careful planning in consultation with the vascular surgeon and the radiologist will best define how to proceed.

Fig. 3 Intraoperative arteriogram shows disruption of the popliteal artery just above the knee after a posterior dislocation.

Consensus exists in the literature that circulation has to be restored within 6 to 8 hours in order to minimize the risk of amputation. In their extensive review, Green and Allen[19] reported a 85% amputation rate in cases in which there was an untreated vascular injury or an injury that was not corrected within 8 hours.

The most common method of vascular repair is resection of the damaged portion of the artery followed by vein grafting. Rarely is the injury so localized that a direct suture is possible. It has been suggested that concomitant popliteal vein injury should be corrected as well, in order to reduce the risk of vein thrombosis and pulmonary embolism.[17,18,20,22] Liberal[17-20,22] and even mandatory[15] use of fasciotomy has been advocated if vascular damage is present, as a prophylactic measure against compartment syndrome and vein thrombosis.

Absolute Surgical Indications

In addition to arterial injury and a state of irreducibility, open dislocation and the presence or threat of compartment syndrome also serve as absolute indications for immediate surgery. If possible, one should try to limit the number of operations and perform ligament repair concomitantly if surgical management of the ligament lesions is elected as the treatment. This can often be done if irreducibility is the cause for acute surgery, sometimes together with vascular repair or debridement of open wounds, if they are not grossly contaminated. However, concomitant ligament repair should be avoided in cases of threatening compartment syndrome because of the additional soft-tissue trauma created by surgery and the higher risk of infection from the fasciotomy incisions. The use of prophylactic antibiotics is recommended for all acute surgery.

Definitive Treatment of Ligament Injuries

Historical Overview

Traditionally, there has been a controversy about the most efficacious treatment of the multiple ligament lesions that result from dislocation of the knee. In the beginning of this century, treatment included 4 to 5 months in a plaster cast, which was gradually shortened to 6 weeks over the following four decades.

In the 1960s, Kennedy[10] and Shields et al[3] advocated early repair

of torn ligaments after their reviews of patients with knee dislocations, some of whom were subjected to surgical repair and others to nonsurgical treatment. In 1969, Reckling and Peltier[14] reported their experience in treating lateral and posterolateral dislocations with ligament repair but still preferred conservative treatment of anterior and posterior dislocations. Results were considered good in that era if moderate instability persisted and if 90 degrees of flexion was possible.

In 1971, Meyers and Harvey[4] used a more formalized, but still rather subjective, rating system to assess results in 7 patients treated nonoperatively and 11 patients who underwent early repair. Better results were seen for the surgically treated group, and the authors became strong advocates of surgical management of ligamentous injuries. Their conclusion was reinforced in 1975 when they reported a 1-year follow-up of 33 patients who were treated surgically.[8]

Contrary to this, Taylor et al[12] in 1972 reported better results for 26 patients treated nonoperatively than for 16 who underwent operative treatment. However, in the latter group, ligament repair was performed in only 3 patients; in the remainder, the operation was used only to treat open wounds, vascular compromise, or irreducibility. The authors concluded that nonoperative treatment gives good results for patients with uncomplicated dislocations.

More recently, all authors have recommended operative treatment for patients with ligament injuries, the possible exceptions being old and sedentary persons[6,11,13,15,20] and those who are clinically stable after reduction.[21] The development of this consensus has been paralleled by the development of newer, more effective knee-ligament repair and reconstruction procedures for the treatment of single- or double-ligament injuries. Today the discussion pertains more to the type and extent of ligament repair or reconstruction, as well as to postoperative rehabilitation, because stiffness is often a greater problem than instability after surgical treatment.

Surgical Treatment

Most authors recommend a delay of surgery unless there is an absolute acute surgical indication, such as irreducibility. One reason for this recommended delay is to allow a period of vascular monitoring. Burger and Larson[25] recommend that patients without initial signs of vascular or nerve injury should be observed for 5 to 10 days in the hospital before surgery. We agree on the need for close observation, but hospitalization of a symptomless individual for such a long period is becoming less defensible. The reviewed literature gives no information on the exact time frame within which the risk for a late arterial thrombosis is high. If the patient is discharged, he or she must be thoroughly informed of the nature of the symptoms of arterial occlusion and should be urged to return immediately for reevaluation if there is the least hint of a problem.

Another reason cited for delayed surgery is to reduce the risk of postoperative arthrofibrosis. Shelbourne et al[6] outlined a treatment protocol based on a follow-up series (minimum, 1 year; average, 3.7 years) of 21 patients who had sustained low-velocity dislocations. This protocol includes reconstruction of the PCL and the lateral and medial structures, but leaves the ACL unattended. If the lateral side is disrupted, surgery should be done within 3 weeks. If the medial ligaments are ruptured, they recommend a delay until full range of motion has been reestablished. This limited repair is motivated by the high risk of arthrofibrosis connected with immediate repair of the medial side and reconstruction of both the ACL and the PCL at the same time. They recommend that reconstruction of the ACL be done later if needed. This protocol is the most explicit published so far; however, their study findings do not support all of their recommendations.

Others recommend repair or reconstruction of all injured structures.[25] In fact, the present dispute regarding the necessity of MCL repair in patients with combined ACL-MCL injuries whose knees are not dislocated is not yet resolved. Early observations of good results of nonsurgical management of the MCL in combined ACL-MCL injuries cannot be extrapolated automatically to the often much more complex ligament injuries of a knee dislocation. We believe that, until prospective controlled studies show differently, the repair or reconstruction of all torn ligaments should be strongly considered in cases of dislocated knees. Regardless of these differences of opinion, the concern for postoperative arthrofibrosis with subsequent restricted motion seems universal.[6,11,13,25]

A widely accepted current opinion about ACL injuries is that surgery should be delayed until swelling has resolved and full range of motion has been regained. In the unstable dislocated knee, maintaining a reduced state is sometimes difficult and has required splinting or even external fixation. In this situation, full range of motion may never be regained. The ability to adequately dissect and repair medial, lateral, and especially posterolateral structures becomes increasingly difficult with the passage of time. In our opinion, surgery for repair or reconstruction is optimally performed after 2, but probably no longer than 3, weeks after knee dislocation.

It is not known whether it is the concomitant repair or reconstruction

of all ligaments or the lack of early mobilization that is the greatest threat to an eventual full range of motion. In most published reports, immobilization of the knee joint in plaster casts has been used for at least 4 weeks, sometimes in combination with transfixing pins; alternatively, transfixation instruments have been used without plaster immobilization. To date, no study has compared immobilization with early range-of-motion exercises. One observation shared by many surgeons is that some patients respond with stiffness in spite of early mobilization, while in others there is no problem with range of motion but gross instability develops after surgery and casting. This introduces the uncontrolled factor of biologic variability. There is no scientifically validated support for any preference regarding the extent and type of repair or reconstruction of the dislocated knee. Likewise, no studies clarify how aggressive the rehabilitation should be. It is important, though, that the high risk of arthrofibrosis in this patient group be properly recognized by the orthopaedist. Moderate instability seems to be preferred by the majority of authors over stiffness, which often results in both functional disability and pain. Bracing with early motion appears to be a reasonable option in selected patients in an attempt to reduce the risk of stiffness, but only if the security of fixation and the strength of the repaired or reconstructed tissues is judged to be sufficient.

Surgical Approach

The approach outlined is always preceded by evaluation and definitive treatment of associated vascular lesions. The ACL and the PCL are accessed through an anteromedial arthrotomy. The extent of the injury determines the need for further incisions. An injury of the medial-ligament complex can be reached from an extended anteromedial incision with the leg in a figure-four position. The lateral structures, including the peroneal nerve, are reached from an additional lateral incision after an incision through the posterior aspect of the iliotibial tract. If necessary, its insertion, together with a bone block from Gerdy's tubercle, can be detached. Both sides can also be reached by a long, straight anterior skin incision and subsequent dissection in the cleavage between the subcutaneous tissue and the fascia of the leg.

Arthroscopy

Arthroscopy is thought to be contraindicated in patients with an acute dislocation, because of the enhanced risk of compartment syndrome caused by fluid leaking out of the ruptured capsule. However, the arthroscope can be of great help when performing delayed surgery. Associated pathologic changes in the menisci are often more adequately addressed arthroscopically than with an open procedure. If arthroscopic reconstructions are preferred for the cruciate ligaments, it is our opinion that this can be accomplished in most cases within 2 to 3 weeks after the injury. Limb swelling must be monitored carefully, and one must be prepared to switch to an open procedure if this occurs. The collateral ligament complexes are extra-articular and must still be repaired with an open procedure.

Definitive Treatment of Nerve Injuries

Both the incidence and the outcome of nerve injuries are still uncertain. Along with several reports of transient palsies with complete recovery come more pessimistic reports of permanent dysfunction. Fifty cases of nerve injury were found among 195 reported dislocations.[3,8,10,12,13,20,21] Of the 50 patients, 16 (32%) recovered completely, 4 (8%) recovered partially, and 30 (60%) experienced no improvement. Symptoms improved in only 3 of 7 patients who underwent surgical exploration. White[26] reported good results after delayed surgery in 6 patients; accordingly, he recommended an expectancy period of 3 months to allow for spontaneous improvement. The available literature on knee dislocations is not sufficient to make a reliable prognosis or recommendations regarding treatment of concomitant nerve injury.

In a summary of the present state of the art of nerve repair, Lundborg et al[27] agree that there may be a theoretical basis for delayed repair, but assert that the practical aspects of microsurgical techniques favor immediate repair of a sharply transected nerve. Areas of nerve disruption, normally encountered in association with knee dislocations, often have ill-defined edges, which must be resected and which require nerve grafting, since neural circulation is very sensitive to even a small increase of tension.[27] The sural nerve is often used for this purpose because of its accessibility and appropriate thickness for the "group fascicular" suturing technique.[27] There is no evidence that a primary resection and suture or grafting of a macroscopically intact nerve yields better results than nonsurgical treatment.

Functional disability often persists after injuries to the peroneal nerve. Impaired dorsiflexion of the foot necessitates prevention of foot drop by the use of orthotic devices or, less frequently, triple arthrodesis. In a young or active individual, restoring active function by a later tendon transfer may be considered.

Management Recommendations

Though many details regarding the definitive treatment of knee dislo-

cations are still to be resolved, there is an obvious need for a well-defined treatment plan for these injuries. The following are some general treatment principles applicable to the dislocated knee, recognizing that modifications are often necessary to meet the individual circumstances of each patient.

(1) Dislocation of the knee should always be suspected in cases of multiple trauma and when gross instability, swelling, or ecchymosis is present.

(2) Knee reduction should be performed in the emergency room if possible and always before referral to another hospital.

(3) Close collaboration with the radiologist and the vascular surgeon in the acute phase is vital. The circulation of the limb must be assessed before and after reduction, as well as in all cases in which there is disruption of three or more major ligaments. Assessment of the arterial circulation by the use of Doppler techniques is recommended over reliance on clinical judgment. In cases of a normal ankle-brachial pressure index, examination of vascular status is sufficient. If the Doppler measurement reveals asymmetric pressure, arteriography should be performed. A vascular surgeon must be consulted immediately if vascular compromise is suspected.

(4) In cases of complete occlusion or disruption, vascular repair must be done within 8 (preferably 6) hours.

(5) Fasciotomy should be performed if a compartment syndrome threatens.

(6) Nerve exploration is of little value unless preparations have been made with a surgeon capable of microscopic group-fascicular suturing or grafting technique, in case a complete nerve disruption is encountered. If acute surgery is performed, ruptured nerve ends can be tagged by nonresorbable sutures for later identification if there is no access to such expertise. A macroscopically intact nerve should not be treated with excision and grafting.

(7) If acute surgery must be undertaken, ligaments should be repaired or reconstructed during the same session unless contraindicated (e.g., if such a procedure would jeopardize vascular repair or if there is a contaminated open injury or a compartment syndrome). In all other cases, ligament surgery should be delayed for 2 to 3 weeks, but no longer. Considerable difficulties with the ligamentous dissection may otherwise be encountered.

(8) All patients who have sustained knee dislocation must be closely monitored for late vascular compromise during the first week after injury.

(9) Knee-motion exercises should be started early if the integrity of the ligaments and the vascular repair permits.

Summary

Knee dislocation is a serious injury with a high rate of associated neurovascular injury. Because of its relatively rare occurrence, all of the present knowledge is based on case reports and retrospective follow-up studies. Accordingly, some aspects of the current definitive treatment are based on assumptions and short-term observations, rather than on scientifically derived differences in outcome between controlled treatment groups.

The traditional system of classification takes into consideration only those patients with persistent dislocation, and the term "complete" creates considerable ambiguity. Knee injuries with multiple ligament disruptions, which are probably more often the result of low-velocity injuries, are definitely associated with vascular complications,[6,7,9] even if the rate may[6] or may not[7] be lower compared with injuries with verified dislocations. Thus, it seems logical to regard these injuries as if knee dislocation had in fact occurred and immediately reduced spontaneously.[6]

In the future, optimal treatment of knee dislocations will continue to demand a high suspicion of vascular compromise and will be facilitated by further developments in standardized protocols for the management of soft-tissue injuries. There will also be a need for prospective research to establish the optimal treatment.

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