INSTRUCTIONAL ARTICLE

Acute dislocations of the knee

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Introduction

Dislocations of the knee are uncommon injuries but account for as much as 0.2% of all orthopaedic injuries.[1-3] This serious injury which involves multiple structures, results in multidirectional instability which is sometimes difficult to address, and when there are associated vascular disruption and nerve injury, these have devastating consequences. It still has an amputation rate of 11% quoted in the literature.[4] It is also now widely accepted that operative management is better than conservative treatment.[5-7]

The objective of this presentation is to discuss the controversies surrounding acute knee dislocations, namely the timing of surgery, the use of angiography and which ligaments should be repaired.

Definition and incidence

The 'acute' phase of a dislocated knee is within the first three weeks of the injury and it is considered 'chronic' thereafter.

Dislocation of the knee is defined as gross instability of two or more ligaments after a traumatic episode which may be of variable intensity.[1,5] A high index of suspicion for a dislocation is required when gross sagittal instability is present. Usually the injured knee presents in the casualty department in an unreduced position, a 'complete' dislocation, or perhaps with a history that it had been reduced prior to presentation. A problem arises with knees that have spontaneously relocated immediately giving rise to the so-called 'functional' dislocation. It is due to these 'functional' dislocations that the true incidence is unknown and as many may be missed or underestimated. Most studies estimate the incidence as 0.2% of injuries seen in trauma or casualty units.[1,2]

Classification

Dislocation is the most severe degree of ligamentous disruption of any joint. The greater the force applied to ligaments the greater will be the disruption, incrementally. Although not considered part of most classifications, the energy of the injury plays a significant role in defining the outcome of the injury.

Injury may be of high energy such as MVAs accounting for 50% of all dislocations reported; low energy, usually sports related <33%; and ultra low energy injuries. The highest levels of energy are associated with the poorest outcomes, and are therefore useful as a prognostic indicator.

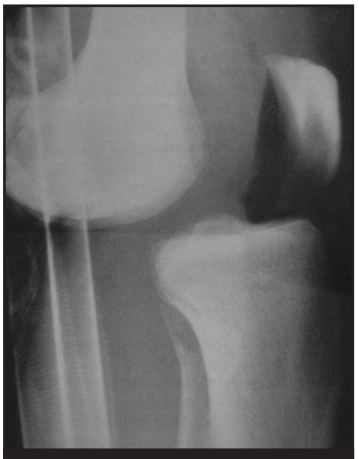

Figure 1:
Anterior dislocation of the knee. The classification is based on the direction of the dislocation as described by Kennedy. The popliteal vessels are at great risk of injury with this dislocation

In an interesting study by Peltola *et al*, 11 of 24 patients (46%) who sustained knee dislocation from a minor trauma were overweight; a simple fall was a common cause (ultra low energy). They emphasise that the treating physician should be aware that, even after a simple fall, obese patients may have a significant injury.[8]

The traditional classification has been to discriminate according to the direction of the dislocation as described by Kennedy[1] *(Figure 1).* A more recent description has been by the pattern of ligament damage as described by Schenck[9] *(Table I).* Kennedy's system describes the direction of the tibial dislocation in relation to the femur, whereas Schenk's system accommodates the concept of increased force causing incremental ligamentous disruption, by describing the ligaments which are torn. The problem with the Kennedy system is that it only recognises those injuries where the dislocation has been documented, thus missing the 'functional' dislocations and although is suggestive of which ligaments are ruptured, it is an unreliable guide. The Schenck or KD classification is confined to the clinical findings on examination, but does appreciate partial injuries and the variable healing potential of the different ligaments.

Anterior dislocations are caused by hyperextension injuries and occur in 40% of all dislocations.[4] In a cadaveric study done by Kennedy, the posterior capsule was first torn at 30° hyperextension, followed by injury to the ACL and then the PCL as the hyperextension continued. The popliteal artery was injured at approximately 50° hyperextension[1] *(Figure 1).* Posterior dislocations are caused by a posterior force, most commonly the dashboard mechanism and number 33%.[4] Significantly more force is needed and the PCL, which is the key to posterior stability, is always ruptured. The ACL is frequently ruptured.[10] Medial (4%) and lateral (18%) dislocations are usually associated with fractures. Of note is that the lateral may be irreducible due to the medial femoral condyle 'button-holing' through the capsule, an indication of which is a medial skin dimple.[2]

The popliteal artery is prone to injury by virtue of its being tethered at the adductor hiatus proximal and distally at the trifurcation

Table I: Injury pattern: Anatomical description of Schenck[9]

KD 1	=	Without both cruciates
KD 2	=	With both cruciates
KD 3	=	Both cruciates and PMC or PLC
KD 4	=	Both cruciates and PMC and PLC
KD 5	=	With a fracture
5/1	=	Without both cruciates
5/2	=	With both cruciates
5/3M	=	Both cruciates and PMC
5/3L	=	Both cruciates and PLC
5/4	=	Both PMC and PLC

Often not commented on is the presence of associated injury to articular cartilage, bone contusion or micro-fractures and meniscal pathology. These associated injuries further add to the potential outcome following dislocation and should in some way be included in the classification and in predicting the outcome.

Associated injuries

Vascular

The popliteal artery is prone to injury by virtue of its being tethered at the adductor hiatus proximal and distally at the trifurcation. The reported incidence varies remarkably from 5% to 80% with the average being 25%.[11,12] Perhaps this discrepant range may be influenced by the method of classification employed. In a retrospective review at Groote Schuur Hospital using the Kennedy system, Walters *et al*[13] reported this to be about 30%, where ten vascular occlusions were encountered in 35 knee dislocations. Of note is that 'normal' pulses do not necessarily equal normal vessels[14] and that capillary refill is a poor indicator of vessel injury. A 'poor' pulse is also not due to vascular spasm. The injury may vary from a complete rupture to an injury to the intima, which can present up to 5-7 days after the injury. Posterior dislocations usually produce complete trans-section of the popliteal artery (direct injury from the tibia), whereas anterior dislocations tend to produce a traction injury of the popliteal artery which leads to an intimal tear.

Treatment of the vascular injury takes precedence over all other aspects. Ischaemia greater than 8 hours leads to an 86% amputation rate, whereas treatment within 8 hours still results in an 11% amputation rate.[4]

Walters *et al*[13] reported an overall amputation incidence of 8.25% (three of 35) of which one case was an intimal tear which was missed initially and presented one week after injury. An interesting observation by the senior author (JW) is that no vascular occlusions were observed in over 20 years of dealing with acute 'three ligament' knee injuries, i.e. ACL, PCL and a collateral, the so-called functional dislocation, although neural injury was common with lateral side injuries. In contrast, the complete dislocations had an associated vascular problem in nearly one-third of the time, suggestive of an order of magnitude difference in the level trauma of the injury.

Neurological

The incidence of nerve injury has been reported from 16% to 50% with an average of 20%.[6,12,15] The common peroneal nerve is usually the involved nerve. Injury occurs in all types of dislocation but neural damage is most frequently seen in association when there is a varus force disrupting the lateral and posterolateral structures. A traction injury is the most common finding usually leading to an axonotmesis, and the severity varies, but 50% have a permanent neurological deficit.[15]

Bony fractures and bruises

Fractures are more commonly associated with lateral and medial dislocations and can be of either the distal femur or proximal tibia. They occur in approximately 16% of knee dislocations.[12] Avulsion fractures of the ACL and PCL may occur as well as avulsion fractures of the lateral tibial plateau (Segond fractures[16]), indicating significant cruciate, collateral and capsular disruption. Undisplaced fractures and bone bruises (75%)[3] may also occur and undoubtedly contribute to morbidity, especially if unrecognised.

Cartilage Injury

Injury can occur to the articular cartilage in the form of a shear avulsion or an osteochondral defect, or to the menisci (50%).[14] The articular injuries are mostly not commented on and therefore their incidence is unknown. They do, however, contribute significantly to the outcome of the patient.

Extensor mechanism injury

Wissman *et al* reporting on an MRI assessment of knees following tibio-femoral dislocation, state that in their study of 14 knees, 36% had an associated partial tear of the patellar tendon.[17] Bui *et al* report biceps femoris tendon injury in 25% of their patients.[3]

Clinical evaluation

Like any displaced fracture or dislocated joint that threatens circulation or neural function, this injury must be dealt with as an emergency. Factors to consider when assessing the knee are listed in *Table II*. In particular the following are critical to assess: vascular compromise, open or closed injury, reduced or not, neural involvement and concomitant injuries.

Prior to investigation and treatment ensure that the knee is reduced. The vascular component must be addressed as an absolute emergency and an open dislocation must be dealt with within six hours of injury. In practical terms these two scenarios are usually dealt with immediately. If the injury allows for a more relaxed approach, further investigation is possible prior to surgery. Ensure that the knee is stabilised.

Table II: Evaluation of the acute dislocated knee

- ATLS first
- Reduced or not?: if not, reduce the dislocation
- Open or closed injury?
- Complete neurovascular examination
- Angiography
- Involve vascular surgeons early
- Secondary survey
- Stabilise limb
- Further investigations (X-rays/MRI)

The neurovascular examination is very important and should be continually repeated. The pulses must be manually felt and compared to the normal side. The ankle-brachial index can be used to supplement the physical examination and although not specific, has a high sensitivity for detecting vascular injury.[18] An index of <0.9 is highly sensitive to a vascular injury (95-100%) and indicates the need for surgical intervention. If the patient presents with a threatened limb (ischaemic changes, absent pulses, >6hrs post injury) then immediate vascular exploration by a vascular surgeon is mandatory (an on-table angiogram in the operating theatre can be done at the vascular surgeon's discretion). There is considerable debate over whether an angiogram should be done routinely with many authors recommending its routine use[4,5,11,14,19,20] and many authors stating that it is only needed in selective cases.[21-23] The latter authors suggest that it is done when there is a documented decreased pulse, change in colour or temperature of the leg, an expanding haematoma, a history of an abnormal finding prior to hospitalisation and when there is surgeon doubt. The use of these criteria will not guarantee diagnosing all the vascular injuries, especially the intimal tears, which may have only subtle differences in the pulse. Arguably an ankle/brachial index of less than 0.9 is the best criteria to use under these circumstances. An angiogram is however the gold standard for diagnosing arterial injuries. If an angiogram is not done, repeat examinations are mandatory every 2-4 hours for up to five days. In our setting in South Africa, and indeed in large parts of the world, with limited resources and staff, this is not practical, and the exclusion of a vascular injury by routine angiogram in all cases is probably the best and safest approach.

Imaging

Anterior-posterior and lateral radiographs are obtained of the knee in the emergency department post reduction. The presence of a fracture may dictate the need for CT to further evaluate the bony injury and plan for open reduction and internal fixation. MRI, although stated as essential by most authors[12,20] for pre-operative planning, is not routinely done at our institution due to cost implications. It is therefore only done in specific circumstances when clinical evaluation is unequivocal. The MRI and CT scans are only obtained in the stable patient with no vascular injury and are done on a non-urgent basis while awaiting definitive management *(Figure 2).*

Management

Although there is much controversy around the management, there is now little doubt that surgical repair as soon after the injury as possible yields the best outcome. Chhabra *et al,* like other authors,[5-7,12,20] found that patients who were repaired or reconstructed acutely had higher subjective scores and better objective restoration of knee stability than did those who had surgery three weeks or more after the injury.[24]

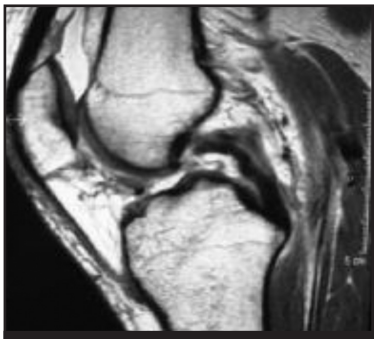

Figure 2:
An MRI demonstrating a tear of the posterior cruciate ligament

Figure 3:
After reduction of a posterior dislocation there is residual posterior subluxation

Figure 4:
The same case as shown in Figure 3. The posterior subluxation has progressed and has become irreducible, as demonstrated by 'hinge extension'

Surgical stabilisation

Those dislocations that need immediate surgery are those that are open, are irreducible, where there is vascular compromise and when there is compartment syndrome. In these cases, if the dislocation is open, washout is undertaken and depending on the wound, an external fixator bridging the knee is recommended.

With vascular compromise, the vessel is either repaired or bypassed first, and then the posterior capsule and postero-medial or postero-lateral corners are repaired through the same incision used for the vascular repair. If the posterior cruciate is torn, troublesome posterior instability may persist following the post capsule. For this reason it is advisable to repair the posterior cruciate by direct suture, and if still necessary apply an external fixator across the knee to provide additional stability.

If none of the urgent indications are present, the surgical repair can be delayed until the status of the soft tissues permits. Once the soft tissues have settled down and before the tissue becomes friable and unmanageable, usually before two weeks after injury,[11,19,20,25] all the torn structures must be repaired by primary suture. The key structures include the following: posterior lateral corner (PLC), posterior medial corner (PMC) – these are critical – the cruciates if amenable, the collateral ligaments and any avulsion fractures. It is reasonable to leave the cruciates and reconstruct them at a later stage; usually 3-6 months later, providing the initial stability of the capsular repair has been achieved. Some advocate a more aggressive approach with allograft reconstruction in the early phase[24] but the cruciates can be addressed at a later stage if the patient has instability symptoms. The emphasis on the acute repair is on the anatomical reconstitution of the structures injured. The surgical approach will be dictated by the ligaments and structures that are injured and torn tissue is identified and carefully sutured using lightweight suture material, no more than 2/0 non-absorbable material. If the menisci are damaged they can be dealt with at the same time preferably by repair. Osteochondral defects must be internally fixed. Pure chondral shear avulsions are more troublesome and may be dealt with by the Steadman pick procedure.

When the PCL is involved and there is a tendency to posterior subluxation the prime objective is to avoid fixed posterior subluxation of the tibia on the femur. This is irreducible even at a later stage and is associated with a poor outcome *(Figures 3 and 4).* In these instances PCL avulsions must be repaired even by direct suture. This will assist in preventing the posterior subluxation initially until the capsule has healed. All posterior instability must be further supported by some or other external means. We prefer to use the posterior cruciate brace described by Stroebel *(Figure 5)* as the use of an external fixator is not as effective at preventing posterior translation of the tibia as one would like, and there is no risk of infection from the pin tracts.

Neurological injury generally carries a poor prognosis as 50% develop a permanent deficit. If nerve palsy is present and one is surgically in the area, the nerve should be explored. The lengthwise bruising of the nerve for injuries 'in continuity' is prognostic. Such an involved nerve exceeding 7 cm has a poor prognosis for recovery.[15] These patients should then be observed for three months in an AFO and watched for signs of spontaneous recovery, which can occur in up to 20%.[25] For the common peroneal nerve, if no recovery occurs, tendon transfers, usually the tibialis posterior through the intermuscular septum to the mid dorsum of the foot, is recommended to provide ankle dorsiflexion. Intra-neural neurolysis and nerve grafts do poorly because the injury has a significant traction component which results in intra-neural scarring extending for a variable and often unknown distance proximally and distally.[15]

Figure 5:
The Stroebel brace utilises a foam rubber pad placed behind the calf muscles ensuring a forward displacement of the tibia on the femur. Ensure that the knee is in extension when the brace is applied to minimise the posterior pull of the hamstring muscles

Rehabilitation

Early rehabilitation has been shown to decrease stiffness after repair[26] and is therefore important to initiate as soon as the soft tissues permit. The knee is initially placed in a locked brace at 0° for four weeks. The Stroebel brace is preferred with any posterior instability. Isometric quadriceps exercises are started on day 1. Passive flexion to 90° is started at four weeks (with the physiotherapist holding the tibia forwards). There is to be no active hamstring function for the first six weeks. At six weeks active assisted and closed chain quadriceps and hamstring muscle functioning is started.

Summary

Acute dislocation of the knee is an uncommon but devastating injury. A high level of suspicion is needed in diagnosing it. Repeated neurovascular examinations are extremely important and even though it is wiser in our setting to do a routine angiogram, this is not a substitute for and does not exempt the patient from receiving a full neurovascular assessment. Outcome is better when the knees are treated surgically – immediately if there is vascular compromise, with the remainder being treated before two weeks as soon as the soft tissues allow. Anatomical restitution of the injured structures is the surgical goal. Avoidance of chronic persistent posterior subluxation and a controlled rehabilitation programme will yield best results.

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