Knee Dislocations in Sports Injuries

Abstract

Knee dislocations are devastating when they occur on the athletic field or secondary to motor sports. The complexity of presentation and spectrum of treatment options makes these injuries unique and extremely challenging to even the most experienced knee surgeons. An astute appreciation of the treatment algorithm is essential to plan individualized management since no two complex knee dislocations are ever the same. Moreover, attention to detail and finesse of surgical technique are required to obtain a good functional result and ensure return to play. Over the past 10 years, our service has treated 43 competitive sportsmen with knee dislocations, and this experience forms the basis for this narrative review.

Keywords: *Knee dislocation, ligament reconstruction, ligament repair, multiligament knee injury, sports injury*

MeSH terms: *Knee dislocation, knee injuries, knee joint, ligaments, multiligament injury*

Dinshaw N Pardiwala, Nandan N Rao, Karthik Anand, Alhad Raut

Centre for Sports Medicine, Kokilaben Dhirubhai Ambani Hospital, Mumbai, Maharashtra, India

Introduction

Knee dislocations are defined as clinical or radiological loss of tibiofemoral congruity. Since many knee dislocations reduce spontaneously and are associated with multiligament disruption; these injuries are now synonymous with knee dislocations. Over the years, the treatment of knee dislocations has evolved from nonoperative treatment to operative repair and reconstruction, which has now been shown to yield better results. The heterogeneity, relatively rarity, and serious nature of these injuries have prevented consensus of treatment. Controversies still exist on the timing of surgery, need for ligament repair, augmentation, or reconstruction; single stage or two-stage surgery, use of autografts or allografts for reconstruction, and postoperative rehabilitation protocols. The aim of this review is to describe the current opinion on the treatment of knee dislocations and multiple ligament injuries in athletes.

Epidemiology

Knee dislocations are complex injuries as they are associated with serious short term complications such as vascular injuries and neurological deficits, and long term consequences such as degenerative joint disease. Knee dislocations account for <0.02% of all orthopedic injuries in the general population[1] and <0.5% of all joint dislocations.[2] Nearly 33% of knee dislocations are secondary to sports injuries and are second only to road traffic accidents (50%) as a cause. Although we have encountered sports knee dislocations in soccer, wrestling, rugby, kabaddi, long jump, skating, cycling, skiing, gymnastics, motor sports, and extreme adventure sports, there is no epidemiological data for knee dislocations in India. Data from the national electronic injury surveillance in the United States reported that 9369 knee dislocations occurred in extreme sports participants over a 6-year period from 2007 to 2012. The estimated incidence was 29.12 knee dislocations per 1 million person-years. The incidence was found to be increasing over the period studied, with maximum in the age group of 10–19 years, and in males. The highest incidence was associated with snow skiing.[3] A 3-year epidemiological study of snow sports found that knee dislocation was the most common specific injury leading to admissions in the state of Victoria.[4] Almost 67% of the patients injured were male, half of them aged 15–29 years, and skiers were predominantly injured more than in other sports (62%). What is more disturbing is that while use of protective equipment has decreased the incidence of other injuries, the incidence of knee sprains and dislocations has increased in snow sports.[5] Other snow and ice-related sports such as snowboarding, ice hockey,

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Address for correspondence:
Dr. Dinshaw N Pardiwala, Kokilaben Dhirubhai Ambani Hospital, Four Bungalows, Andheri (W), Mumbai - 400 053, Maharashtra, India.
E-mail: pardiwala@outlook.com

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and ice skating had a lower rate of knee dislocation at 4% or less.[5]

Classification

Knee dislocations can be classified based on either the direction of tibial displacement relative to the femur (Kennedy position classification system) or the ligaments disrupted in the process (Schenck anatomic classification system).

The Kennedy system classifies knee dislocation into anterior, posterior, lateral, medial, and rotatory [Table 1]. Rotatory dislocations were later subclassified into anteromedial, anterolateral, posteromedial and posterolateral.[6] Although this classification system is well established, useful in determining the reduction maneuver needed and correlates to potential associated injuries, it has limitations. Often knee dislocations are spontaneously reduced before medical evaluation (up to 50%), and hence, unclassifiable by the position system. Second, this system only suggests likely ligamentous involvement, and the many possible combinations of cruciate and collateral ligament disruptions are not defined.

Hence, Schenk classified knee dislocations in terms of ligaments involved [Table 2], and this is best done during the time of presentation, or during examination under anesthesia (EUA). This anatomic classification system describes the ligaments torn and is useful in deciding treatment. The higher the number, the more severe the injury is. Thus, a classification of KDIIILCN denotes a bicruciate injury with torn lateral collateral ligament (LCL) and posterolateral complex, and an injury of the popliteal artery, and neural injury (most commonly, peroneal nerve). This classification system allows for accurate discussion of injuries and allows for comparison of like injuries in the wide spectrum of knee dislocations.

Table 1: Kennedy "position" classification system for knee dislocations

Type (Direction)	Radiograph	Salient features
Anterior		Most frequent: 40% Mechanism: Hyper extension No medial or lateral damage Sometimes intact PCL Vascular damage common
Posterior		Nearly as frequent: 30% Mechanism: Direct posteriordrawer Sometimes ACL intact Vascular damage common
Medial/lateral		Rare occurrence if pure Most of the time posteromedial or postero-lateral ACL + PCL Vascular damage if posterior Nerve damage in medial dislocations
Rotatory		Rare occurrence Complex associated lesions

PCL=Posterior cruciate ligament, ACL=Anterior cruciate ligament

Table 2: Schenck anatomic classification system for knee dislocations

Type	Description
KD I	Knee dislocation with either cruciate intact
KD II	Bicruciate injury with collaterals intact
KD III	Bicruciate injury with one collateral ligament injury
	KD IIIM - bicruciate injury with medial collateral ligament injury
	KD IIIL - bicruciate injury with lateral collateral ligament injury
KD IV	Bicruciate injury with both collateral ligament injury
KD V	Periarticular fracture dislocation

Associated injuries - C=Arterial injury, N=Neural injury

Approach to Acute Knee Dislocations

Sports persons may present immediately following an on-field or training injury with an acute dislocated knee or a reduced multiple ligament deficient knee injury. Some athletes may present in the subacute phase after obtaining primary treatment elsewhere.

Acute injury

Patients may present with a dislocated knee [Figure 1] or a spontaneously reduced knee following a dislocation. All severe knee injuries sustained in contact sports, combat sports, and high-speed sports such as gymnastics and skating should be viewed suspiciously as these may be spontaneously reduced knee dislocations and can be associated with neurovascular complications. Any motorsport or extreme sport polytrauma should be first managed with standard ATLS protocols to rule out and manage other injuries such as brain concussion and head injury. Grossly, deformed limbs should be gently repositioned. Often, this itself reduces the joint. No attempt at formal reduction of the joint on the field should be attempted before confirming the radiographic status of the knee. Limb perfusion and neurological status of the knee should be evaluated as detailed in the subsequent section.

In the acute setting, after limb perfusion is confirmed, an immediate radiograph should be performed [Figure 1b] to understand the type of dislocation and whether there is any associated fracture. The dislocation should then be reduced under anesthesia as soon as feasible. Usually, traction followed by gentle extension is all that is required to achieve reduction; however, this would be dictated by the type and direction of dislocation. Following reduction, a detailed physical examination (EUA) of knee ligament stability should be performed. The Lachman's test (anterior cruciate ligament [ACL]), posterior sag and posterior drawer test (posterior cruciate ligament [PCL]), valgus (medial collateral ligament [MCL]) and varus (LCL) stress test, and dial test or external rotation thigh-foot angle test (ERTFAT for PLC) usually suffice in the acute testing.[7] The other tests, which involve a greater degree of manipulation of the knee, are not warranted. If the knee is not grossly unstable, and there is no indication for emergency intervention, the knee is immobilized in full extension a long knee brace. If the knee is extremely unstable or dislocates after reduction then temporary external fixation maybe required. At times, the knee may require immobilization in 20° of flexion to avoid posterior subluxation of the tibia due to an incompetent posterior capsule.[8]

After reduction in the emergency room, it is advisable to get anteroposterior and lateral radiographs to confirm joint reduction, identify avulsion fractures around the knee, and assess the need for associated fracture surgery. In the presence of fractures, further evaluation with a computed tomography (CT) scan may be useful. A magnetic resonance imaging (MRI) is mandatory in knee dislocations to determine the extent of soft-tissue injury and characterize the injury to the ligaments and muscles-tendons.[9,10] This significantly aids in surgical planning and should be done early in the treatment process. Stress radiography may be considered in select cases to document the extent of ligamentous laxity. Regular monitoring of the distal pulsations and ankle brachial index (ABI) (measured as ankle systolic blood pressure/arm systolic blood pressure)

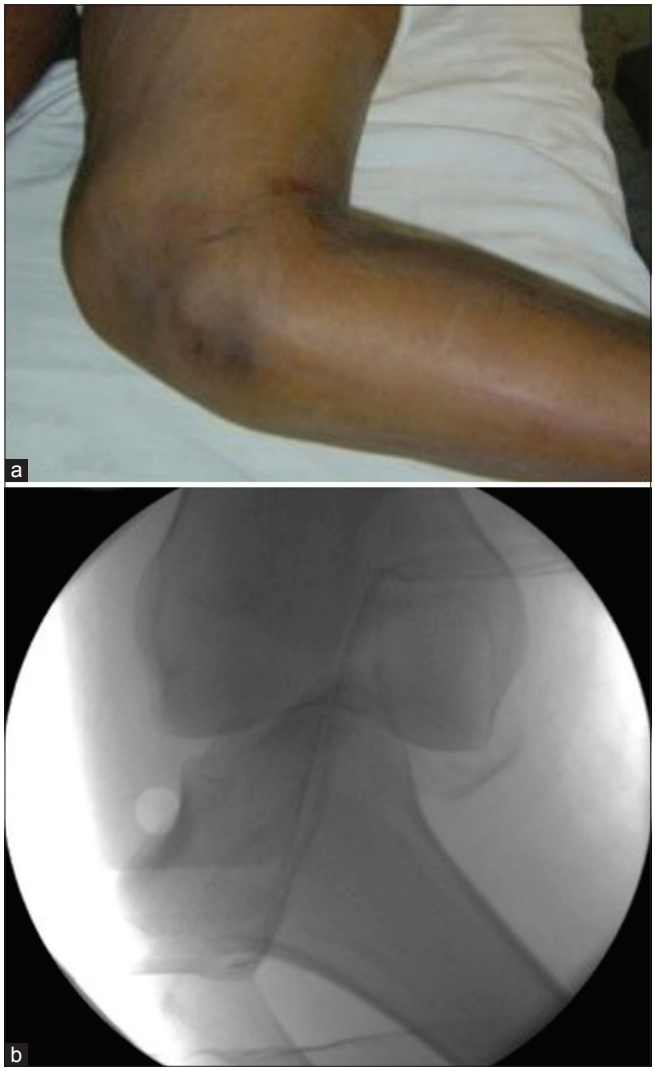


Figure 1: Acute knee dislocation in a competitive martial arts athlete. (a) Clinical photograph (b) radiograph of knee joint anteroposterior view before closed reduction under anesthesia showing dislocation of knee

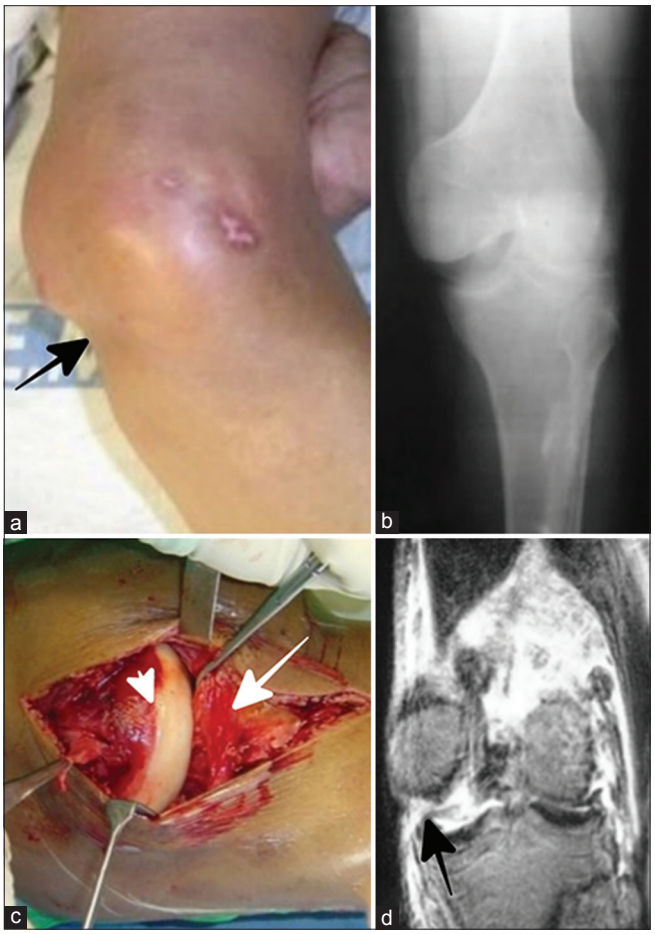


Figure 2: (a) Clinical photographs of irreducible posterolateral knee dislocation showing classical transverse furrow. (b) radiograph of the knee joint anteroposterior view of same patient showing dislocation of knee joint (c) Peroperative photograph showing a complex joint dislocation, in which the medial femoral condyle (white arrow head) buttonholes through the medial capsule (white arrow). (d) MRI showing medial collateral ligament invaginated into the knee joint, preventing closed reduction (black arrow)

should be done in acute setting for at least 72 h. Any fall of the ABI below 0.9 is an indication for angiography. Many centers advocate routine vascular studies for any multiple ligament injured knee.

The indications for emergency surgical intervention in the acute phase are as follows:

1. Irreducible knee dislocation – soft tissue or bony incarceration is the usual cause for irreducibility following a knee dislocation. A posterolateral knee dislocation with MCL invagination causing medial femoral condyle buttonholing is well described [Figure 2]. There is a skin dimple on the anteromedial aspect at the level of the joint ("dimple sign"). This becomes prominent when knee is extended as the MCL is sucked into the joint. We have also encountered popliteus muscle interposition causing irreducibility in a patient with a KDIIILN type of injury, and a displaced tibial eminence fracture causing irreducibility in a KDV type of injury. All irreducible knee dislocations warrant urgent open reduction. Extraarticular repair of torn collaterals and the extensor apparatus should be completed at this first stage. Bony avulsion repair of cruciates may be performed at this stage; however, we do not recommend ACL/PCL reconstruction in the emergency setting
2. Open knee dislocations [Figure 3] – These warrant emergency lavage, closure of soft-tissue cover under drains, and immobilization, with antibiotic cover similar to open fractures. Extraarticular repair may be attempted if the wound is clean after debridement. If an external fixator is applied then a margin of 10 cm above and below the joint line is to be kept so as not to interfere with future tunnel placement for ligaments.[11] The external fixator is kept till acceptable soft-tissue healing or till vascular reconstruction healing is achieved, without jeopardizing the time duration within which ligament repair if required is to be done
3. Vascular injuries [Figure 4] – If distal pulsations are not palpable and not present on bedside Doppler examination despite reduction, the patient is shifted to the operating room, and intraoperative angiography is done. Arterial repair or bypass grafting with four-compartment fasciotomy is performed. A temporary joint spanning fixator may be required
4. An extremely unstable knee may warrant a temporary joint spanning external fixator for knee immobilization till soft tissue healing is achieved
5. Compartment syndrome warrants immediate release of all four leg compartments.

Vascular injuries

A recent systematic review has found that 18% of knee dislocations have an associated vascular injury[12] with reported incidence being as high as 64%.[8] Nearly 80% of these patients underwent a vascular repair and 12% of the patients underwent an amputation. Most of the amputations were a consequence of failed repair or an infection. Patients with maximum incidence of vascular injury were KDIIIL (32%) and posterior dislocations (25%). Patients with an open injury and increased BMI have been found to have increased incidence of vascular injury.[13] However, in general, sports dislocations have a lower rate of vascular injury as compared to high-velocity injuries.[14]

Early detection and treatment of vascular insult are critical as amputation rates following early intervention (within 8 h) are 11% and a delay beyond 8 h results in 86% amputation rates.[15] Even so, residual amputation rates after surgery are 10%.[16] The most common arterial injury involves the popliteal artery. This is due to the fact that popliteal artery is tethered proximally at the adductor hiatus and distally at the soleus arch.

A patient with definite signs of ischemia (absent distal pulsations of the dorsalis pedis or posterior tibial artery)

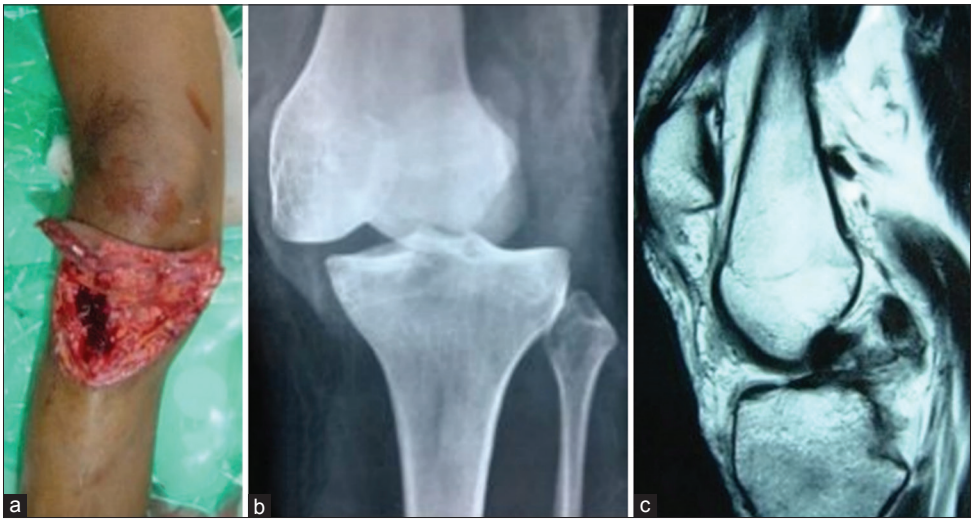


Figure 3: (a) Clinical photograph of knee joint showing open knee dislocation (b) X-ray of knee joint anteroposterior view showing dislocation of knee joint (c) Sagittal T2W MRI showing multiligamentous injury

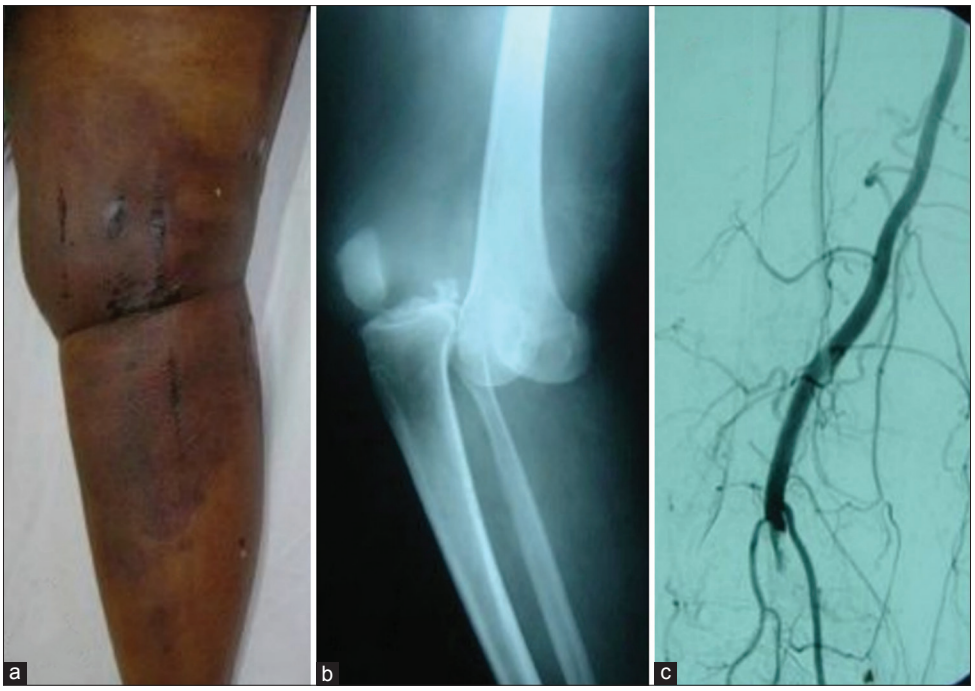


Figure 4: (a) Clinical photograph of knee showing knee dislocation in an obese shot put athlete (b) Radiograph of knee joint lateral view showing anterior dislocation of knee joint of same patient (c) Arteriogram of same patient showing popliteal artery injury

needs to be shifted to the operating room immediately where an intraoperative angiography is done and treated accordingly. Arterial repair for short segment injuries and interpositional grafts (usually contralateral saphenous vein graft) for long segment injuries is often needed. Patients with either asymmetric pulsations or ABI <0.9 need further workup with either a CT or MR angiography.

Angiography is an invasive procedure with its associated risk. Recent advances have enabled CT angiography to be highly sensitive and specific (up to 100% sensitive and specific)[10] while being less invasive and involve lesser radiation.[17,18] MR angiography is our investigation of choice since it is equally accurate without the risks of radiation, and can be performed in the same sitting, as all patients would be evaluated with an MRI.[19]

Patients with palpable dorsalis pedis and posterior tibial pulse with ABI of 0.9 or greater were found to have a sensitivity of 100% to rule out vascular injury. However, even these patients need to be monitored for at least 72 h to rule out delayed thrombosis and vascular insult.

There has been a long standing debate between the proponents of routine angiography and selective angiography with the former claiming that small intimal tears leading to delayed thrombosis maybe missed; leading to disastrous complications. However, recent studies have shown that selective angiography is the standard of practice.[20]

Peroneal nerve injury

The common peroneal nerve is the most commonly injured nerve after knee dislocations. The incidence, in general, is 14%–25%, with as high as 41% cases reported after posterolateral complex (PLC) injuries.[21] Approximately 8% of peroneal nerve injuries have been attributed to sports specific knee fractures and dislocation.[22] Skiing (50%) and football (27%) were the most common sports related to peroneal nerve injury.[22] Further, out of these patients, 25% patients needed a neurolysis, and the rest needed nerve grafting. Patients who needed nerve grafts <6 cm fared better than those who needed longer grafts.[22]

Approximately 30% of cases have a complete neurological palsy and the rest have a partial peroneal nerve palsy.[23] Only 38.4% patients with a complete palsy, and 87.3% patients with incomplete palsy have been found to have functional recovery (MRC grade ≥3).[24]

Treatment options for complete nerve palsy include ankle-foot orthotic support, neurolysis, tendon transfer, nerve transfer, and combined nerve/tendon transfer. Treatment for partial nerve palsy included nonoperative, neurolysis, nerve transfer, and combined nerve/tendon transfer.[25]

Subacute injury

In sports persons presenting after 72 h, pain usually subsides, and concerns over vascular injury have abated. Patient evaluation then is concentrated over the ligaments injured the soft tissue condition and to rule out neurological injury. A detailed radiological evaluation including radiographs, MRI, and if necessary, a CT scan is indicated.

Treatment

The principles of treatment of multiligament injury include identification and treatment of all torn ligaments [Table 3] with accurate tunnel placement, anatomic graft insertion sites, utilization of appropriate and strong graft material, secure graft fixation, and supervised rehabilitation program.[10] The complex anatomy of the knee with wide variation in severity and extent of injury, coupled with various treatment protocols, and multiple outcomes scores reported in an equally voluminous literature, has resulted in controversies in treatment in knee dislocations. Recent literature has shed some light on the various aspects of management of knee dislocations in sports persons.

Operative versus nonoperative

A systematic review has conclusively demonstrated that operative treatment results in better functional outcome as compared to nonoperative treatment (International Knee Documentation Committee [IKDC] excellent/good results 58% vs. 20%) and a higher return to sports (29% vs. 10%). However, the mean range of motion (126° vs. 123°) and flexion loss (4° vs. 3°) were not significantly different in both the groups.[26] A meta-analysis also supported the concept of operative treatment over nonoperative treatment as it yielded better outcome scores and range of motion.[27]

Early versus late surgery

Sports persons undergoing surgery within 3 weeks of injury have been shown to have higher return to sports as compared to those who undergo surgery in the chronic stage (>3 weeks usually at a mean of 51 weeks). However, the functional outcome scores and outcome measures were reported to be similar in both the groups.[26]

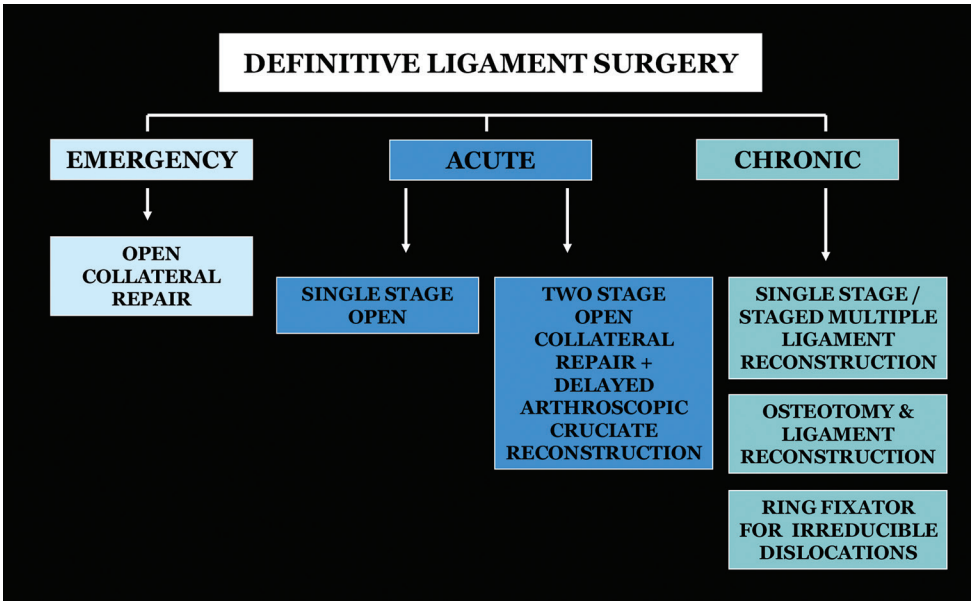
Repair versus reconstruction

In a study comparing ligament repair with ligament reconstruction, especially for the posterolateral complex (PLC), it was found that PLC repair had a higher failure rate than reconstruction (37% vs. 9%). Return to sports was higher with reconstruction than repair of the PLC (51% vs. 23%).[28] Similarly, another study has demonstrated that while the functional outcome scores may be similar in ligament repair and reconstruction groups, patients who undergo repair have a greater flexion loss, posterior sag, and lower return to pre-injury activity level.[29] However, a systematic review found no difference between outcomes of repair and reconstruction of ACL and PCL for these injuries, but the criteria of return to sports was not taken into consideration.[26] A recent study has reported a 81% return to sports rate at a mean followup of 55 months with excellent functional outcomes for a new technique of en masse repair of lateral side structures in multiligament injuries.[14]

Early simultaneous repair versus staged repair or reconstruction

While early intervention has been shown to give better results, there has been debate whether all the ligaments should be repaired and reconstructed in one stage simultaneously or whether the procedure should be staged. A systematic review of 12 articles and 150 patients has reported that staged repair gives better clinical outcomes (79.1%) than simultaneous ligament surgery in acute cases (58.4%) and chronic cases (45.5%). Similarly, there was no difference in outcomes of KDIIIM and KDIIIL knees.[30] In a study on staged reconstruction of multiligament injuries in general population consisting of sports persons, 70% patients had an IKDC score of more

Table 3: The algorithm for ligament surgery in a knee dislocation based on time of presentation



than or equal to B. However, the specific outcomes in sports persons and return to sports was not reported.[31]

Staged surgery includes collateral ligament repair and/or reconstruction in the acute stage (<3 weeks) followed by supervised rehabilitation for 3–6 weeks. Once knee range of motion is achieved beyond 100°, in the second stage, ACL and PCL reconstruction is performed. The advantages of staged surgery include shorter operative time, decreased chances of infection, and decreased chances of arthrofibrosis.[32,33]

Choice of graft

The graft options for sports persons who require ligament reconstruction include autograft, allograft, and artificial ligament (Ligament Advanced Reinforcement System [LARS]). With limited autograft options, morbidity, and resultant weakness after harvesting multiple autografts from the same limb or from the opposite limb, and its impact on sports performance; often surgeons may need to resort to allograft for reconstruction. Reconstructions with allografts have been associated with good results.[34] However, allografts are associated with the rare risk of disease transmission, concerns of immune rejection, and may not be available in all countries due to legal regulations.[35] One study of multiligament reconstruction in the general population reported good functional results at mean 54 months with LARS. However, patients were left with mean flexion loss of 14.6° and extension loss of 2.6° which may not be acceptable in athletes.[35]

Sequence of graft tensioning and fixation

The sequence we normally follow in tensioning and fixing grafts for multiple ligaments reconstruction and the rationale for the same is: (1) PCL double bundle graft passed (2) ACL single-bundle graft passed (endobutton femoral fixation) (3) PCL double-bundle grafts fixed (4) PLC grafts passed and fixed (5) ACL tensioning and tibial fixation (6) MCL and posterior oblique ligament (POL) grafts passed and fixed.

The PCL is always tensioned and fixed first. This is the central pillar and fixing this reduces the knee and achieves the basis for anatomical reduction of subsequent ligaments. If in doubt (with a very unstable knee), we confirm anatomical reduction with a C-arm if necessary. If a single-bundle graft is used, we tension the graft at 90°. If a double-bundle graft is used, we first tension the AL bundle at 90° and the PM at 0°.

The PLC (anatomical) is fixed next since integrity of PLC is a critical prerequisite for tibiofemoral orientation when an ACL graft is tensioned. We normally fix both the femoral sockets first and the tibial tunnel last (I often don't use a fibular screw). The knee is kept in 30° of flexion with valgus force during tightening and fixation.

The prepassed ACL (with endobutton) is fixed on the tibia next. This achieves the 4-bar cruciate linkage system. We always use a single bundle in the context of a multiple-ligament injured knee. The graft is tensioned at 30° of knee flexion in neutral rotation.

The MCL-POL is tensioned and fixed last. The MCL is tensioned in 30° of flexion with varus corrective force to close knee joint of any possible medial opening. The POL is tensioned and fixed in full extension because this is when the POL is tightest in a normal knee.

Although there is a lack of scientific data to back this exact sequence, to us, this is the most logical and scientific way to go about it.

Patterns of Injury and Management

Management of KDI and KDII injuries are fairly well characterized in literature. Meanwhile, KDIII and KDIV ligament injuries, which are more frequently seen in true knee dislocations, are a major area of research in the current literature.

Medial side injuries

Medial side injuries can be either classified as KDIII or when associated with lateral side injuries as KDIV. Medial side structures, which prominently contribute to stability, are the superficial and deep MCL, menisco-tibial ligaments, popliteal oblique ligament (POL), posterior horn of medial meniscus, and semimembranosus. It has been found that medial side injuries are more severe in KDIIIM dislocations than in KDIV dislocations. In KDIII dislocations, the POL (100% cases), and deep MCL (43%), were commonly injured as compared to KDIV (72% and 17%, respectively).[36]

Operative management

Patients with Grade 3 combined instability, tibial-sided MCL injuries, an incarcerated MCL, or Stener lesion (MCL torn and flipped over the pes anserinus) are indications for surgery.[36]

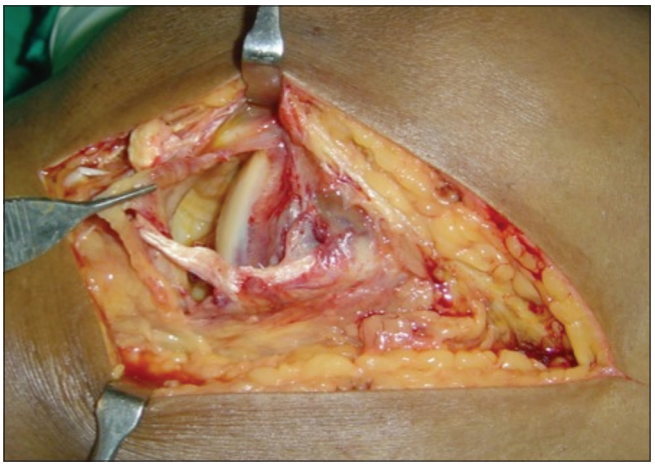


Figure 5: Peroperative photograph showing open-medial collateral ligament repair as a first-stage surgery in an acute KDIIIM knee dislocation in a footballer. The patient underwent subsequent second stage arthroscopic bicruciate reconstruction

1. Repair: If a repairable thick sleeve of MCL avulsion is found then repair is feasible [Figure 5]. In acute midsubstance complex tears, MCL repair with augmentation may be warranted
2. Reconstruction: In acute cases where the tissue is irreparable, and in chronic cases, reconstruction is indicated.[36]

Various techniques for medial side reconstruction have been described and can be broadly classified as[39]

1. Anatomic (single bundle and double bundle)
2. Nonanatomic (single bundle and double bundle)
3. Nonanatomic tendon transfer.

A systematic review of these techniques reported the anatomic techniques to be superior with better objective stability, radiological, and outcome scores. Precise anatomical and radiological landmarks have been described for reconstruction of various medial side structures.[38] Among the anatomic techniques, the double-bundle anatomic technique was shown to result in <3 mm joint opening on stress radiography with no subjective instability at short to medium term followup in all patients.[40] The other two techniques, i.e., single-bundle anatomic and nonanatomic produced the above result in 87% patients. In all techniques, the superficial MCL graft is tensioned in 30° flexion, varus stress, and neutral tibial rotation. The best position of knee for tensioning the POL has been variably reported at 0°, 30°, 45°, and 60° but tensioning at 0° was found to be better.[39]

Timing of surgery

Some surgeons prefer to deal with medial side injuries and bicruciate ligament injuries in the same sitting[36] while others prefer to do an MCL repair or reconstruction with PCL reconstruction followed by ACL reconstruction after knee range of motion is regained. The proponents of staged repair state the differences in ACL and PCL rehabilitation protocols and lower incidence of arthrofibrosis.[41] Postoperatively, range of motion is to be started as soon as possible within the 1st week with weight bearing being a surgeon-dependent variable but usually delayed for 3 weeks.

Lateral side injuries

Functional anatomy

The lateral side comprises static and dynamic stabilizers. The static stabilizers include the fibular collateral ligament (FCL), popliteofibular ligament (PFL), and the posterolateral joint capsule. They act as primary restraint to varus stress and secondary restraint to posterolateral rotation of tibia. The popliteus muscle and tendon with the PFL act as a primary restraint to external tibial rotation at 30° and secondary restraint to varus stress.[10]

Epidemiology

The incidence of lateral side injuries in patients with knee ligament injury is 16%. More than 70% of the acute PLC injuries are associated with either ACL or PCL or both injuries.[42,43] A systematic review found that of all chronic PLC injuries 6% patients had concomitant ACL and PCL injuries.[44]

PLC repair versus reconstruction

Unlike medial side structures, lateral side structures seldom heal and Grade 2 and Grade 3 injuries in the setting of knee dislocation or associated PCL and ACL injuries are indications for surgery [Figure 6]. It has been found that PLC reconstruction is better than PLC repair with failure rate of repair being 37%–40% and that of reconstruction being 5.5%–9%.[28,45] Within 3 weeks of injury, a combination of repair and reconstruction to provide a stable PLC appears prudent.[10]

Anatomical reconstruction of the PLC has been shown to provide good results and helps reconstruct the FCL, popliteus, and PFL. This technique requires two grafts. The first graft replicates the FCL and PFL and is passed from a tunnel in femur, through a tunnel in the fibula (from anterior to posterior) and into a tibial tunnel. The second graft for popliteus passes from a tunnel in femur to join the previous graft in the same tibial tunnel. The graft is fixed in two tunnels in the femur, one each in tibia and fibula with interference screws.[46] The tensioning of the graft should be done in 30° flexion and slight internal rotation.

Outcomes

Very few studies have compared the outcomes of treatment of KDIII medial and lateral side injuries. Although objective scores did not show any difference, subjective scores for PMC repair and reconstruction as a group were better, with better return to sports than patients with PLC reconstruction (PMC42% vs. PLC20% return to same level of sports). Similarly, early PLC reconstruction (<3 weeks postinjury) had better results (72%) than those

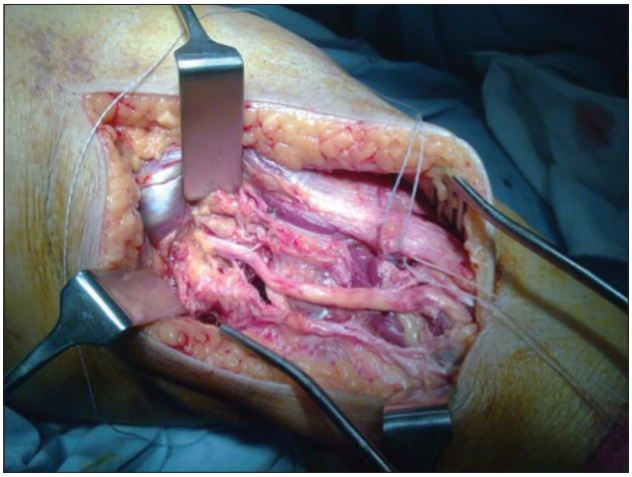


Figure 6: Peroperative photograph showing acute PLC repair (Stage 1 surgery) in case of KDIIILN knee dislocation following a skating injury. Note the peroneal nerve decompression

who underwent reconstruction thereafter (44%).[47] On average, 66%–79% patients KDIIIM injuries obtained good to excellent outcomes as compared to 44%–57% in case of KDIIIL injuries.

Knee dislocations due to sports injuries had similar outcomes as compared to high-velocity injuries. As expected, the KDIII knees fared better than KDIV knees.[36] The reoperation rate was 28%, with stiffness (15%–18%) being the most common reason. The failure rate of reconstructions is 3%–4%, with an infection rate of 4%–5%.[36,41]

Associated meniscal and cartilage lesions

As long term followup of sports persons with knee dislocation was made available, it was realized that associated meniscal and cartilage lesions also influence the outcomes. Significant cartilage injuries were defined as any Grade 2 cartilage injuries involving >50% of condylar width, or any Grade 3 or 4 lesion. Significant cartilage lesions were observed in 40% knees and meniscal injuries in 56% knees (isolated medial 22%, isolated lateral 22%, and combined 12%). The most common cartilage lesions involved the medial femoral condyle (20%) and patella (18%). Patients with any cartilage lesion and combined meniscal tears had significantly inferior results over a followup of 6 years.[48] Lateral-sided injuries tend to have more cartilage and meniscal injuries, and these tend to increase with chronicity.[25]

Chronic Knee Dislocation

In the past 20 years, the senior author has treated 26 chronic unreduced knee dislocations, however, only one of these was in a sportsman (high-velocity motorcycle accident in a remote rally location resulting in polytrauma and a missed posterolateral knee dislocation presenting 3 months following injury). These cases are extremely challenging and warrant open reduction, hinged external fixator application, with or without staged ligament reconstruction [Figure 7].

Patients may also present in the chronic phase with a reduced knee dislocation and a multiple ligament deficient knee. The limb alignment is important to assess in these patients. In patients in whom limb alignment is normal, a single-stage multiple ligament reconstruction is indicated. Patients with limb malalignment (commonly varus mal-alignment in a PCL-PLC deficient knee) should undergo corrective osteotomy (with or without slope modification) in the first stage before any subsequent ligament reconstruction.

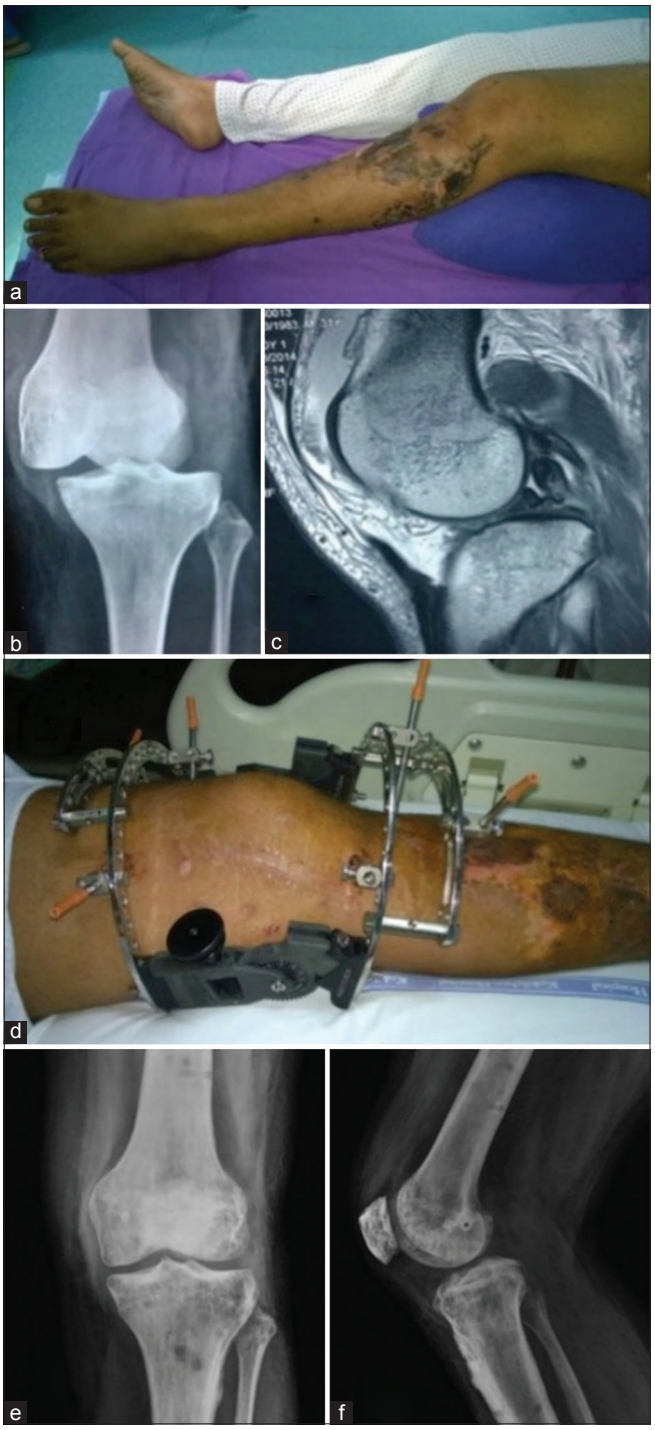


Figure 7: (a) Clinical photographs of a 3-months old unreduced posterolateral knee dislocation following a high-velocity motorcycle accident with polytrauma. The injury occurred at a remote high-altitude location during a rally and a resulted in a missed knee dislocation (b) Radiographs of knee anteroposterior view showing lateral knee dislocation (c) Sagittal Magnetic Resonance Imaging showing multiligamentous injury (d) Clinical photograph after open reduction showing hinged external fixator *in situ*. (e and f) 18 months followup x-rays anteroposterior and lateral views showing well reduced dislocation. He had staged multiple ligament reconstruction using allograft

Sequelae and Complications

The most common complications after the treatment of knee dislocation are persistent pain, arthrofibrosis, and persistent instability. Approximately 25% to 68% of patients complain of chronic pain of varying severity; the causes of which are multifactorial. Nearly 5%–71% of patients develop arthrofibrosis with a mean of 29% patients requiring resurgery for adhesiolysis. Sportspersons who

undergo early simultaneous repair and reconstruction of three or more ligaments are at higher risk of knee stiffness after surgery. The prevalence of persistent instability in at least one plane after surgery ranges from 18% to 100% with a mean of 42%.[10]

Conclusions

Few injuries challenge both the athlete and the surgeon as much as knee dislocations and multiple ligament knee injuries, often raising the question of whether the athlete will ever be able to return to play. The treatment of knee dislocations has evolved from nonoperative treatment to operative repair and reconstruction. The principles of treatment of multiligament injury include identification and treatment of all torn ligaments with accurate tunnel placement, anatomic graft insertion sites, utilization of appropriate and strong graft material, secure graft fixation, and supervised rehabilitation program. The heterogeneity, relatively rarity, and serious nature of these injuries have prevented consensus of treatment. Although controversies exist, it is now apparent that operative treatment results in better functional outcomes as compared to nonoperative treatment, and athletes undergoing surgery within 3 weeks of injury have been shown to have higher return to sports as compared to those who undergo surgery in the chronic stage.

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Conflicts of interest

There are no conflicts of interest.

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