Trauma Case Reports 46 (2023) 100846

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Immediate identification and management of an open posterior knee dislocation: Important lessons from a case report

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ARTICLE INFO

Keywords:
Posterior knee dislocation
Open fracture
Multi-ligament rupture
External fixator
Vascular injury

ABSTRACT

Traumatic knee dislocation represents a rare event, contributing to less than 0.02 % of all orthopedic trauma and 0.05 % of joint dislocations, respectively. It is critically important to recognize, identify, and appropriately manage such cases as 'time' is implicated as an outcome-determining factor. Thus, such cases warrant quick consideration and appropriate management to mitigate the possibility of neurovascular damage and long-term sequelae. We report a case of a 59-year-old man struck by a motor vehicle in a remote rural community in northern Mexico managed with external fixation 16 h after the initial trauma, and later resulting in a supracondylar amputation. The authors of this case report underline the importance of timely intervention strategies when faced with such cases of knee dislocation and promote enhanced training of peripheral trauma-care providers to help improve patient outcomes.

Introduction

Traumatic knee dislocation represents less than 0.02 % of all orthopedic trauma and 0.05 % of joint dislocations respectively [1,2]. Although rare, traumatic knee dislocation is a complex and potentially limb-threatening event that is further complicated in the presence of neurovascular or ligamentous injury. It is vital to recognize, identify, and appropriately manage these situations; as timely intervention quickly becomes an outcome-determining factor that must be considered and managed to reduce complications or even death. We report a unique case of an open posterior knee dislocation with complete rupture of the anterior cruciate ligament (ACL), medial collateral ligament (MCL), Lateral collateral ligament (LCL), and posterior cruciate ligament (PCL) in a 59-year-old male pedestrian struck by a motor vehicle in a remote rural community.

Case report

A 59-year-old male was brought by Emergency Medical Services (EMS) to a regional tertiary care hospital center after being struck by a motor vehicle while crossing a rural interstate highway 16 h prior. The patient was found responsive and injured at 0200 by law

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https://doi.org/10.1016/j.tcr.2023.100846
Accepted 15 May 2023
Available online 16 May 2023

enforcement prior to the arrival of EMS. Initial EMS evaluation reported the patient to be alert, breathing spontaneously, inebriated and combative, GCS of 14, ETOH-like odor on breath, visible left lower extremity deformity with external rotation and a 15 × 5 cm lesion with profuse active bleeding exposing the left femur. The extremity was pale and cold to the touch with a weak distal pulse vaguely palpable. Initial vitals at the scene reported Blood Pressure (BP) 90/60 mmHg (MAP 70 mmHg), Heart Rate (HR) 100, Respiratory Rate (RR) 20, Pulse Oximetry (SPO2) 99 %, Temperature 36 Centigrade, and Shock Index of 1.1. The patient was stabilized prior to transport to the nearest rural Emergency Department (ED).

Upon arrival at the rural ED, the patient was hemodynamically stabilized and further evaluated. Point of care Venous Blood Gas (VBG) revealed metabolic acidosis with a pH of 7.12, partial pressure of Oxygen (PO2) 22, partial pressure of Carbon Dioxide (PCO2) 49, Bicarbonate (HCO3) 18.3, Lactate 8.8, and Base Excess of −10.1; a Complete Blood Count with differential was found to be within normal limits. With the lack of locally available surgical specialists and resources, transportation to a higher level of care 6 h away was planned. During this period, 4 h elapsed before transportation became available.

Upon arrival at the secondary referral center ED, the patient was re-evaluated and was decided to be further transported to a tertiary referral center for the management of an open posterior knee dislocation with traumatic rupture of the ACL, PCL, LCL, and MCL with complete open exposure of a pulseless popliteal fossa. Sixteen hours after the initial trauma the patient successfully arrived at a tertiary care hospital where he was immediately evaluated per Advanced Trauma Life Support protocol. Vitals were stable and exam was remarkable for left lower extremity deformity, a 15 × 5 cm lesion with exposed medial femoral condyle, no active bleeding, cyanosis of the distal third of the extremity, non-palpable distal pulses and a 5-s capillary refill (Fig. 1). Lab workup was remarkable for Hemoglobin of 9.72, Hematocrit 27.7 on CBC; VBG pH 7.35, PO_2 40, PCO_2 40, HCO_3 22.1, Lactate 4.2.

The dislocation was immediately reduced (Fig. 2), damage control resuscitation and wound irrigation was done. No clinical improvement in perfusion was observed. A bedside doppler ultrasound performed in the Resuscitation Area revealed monophasic weak posterior tibial flow with no identifiable pedal pulse. Due to persistent joint instability after reduction, the patient was moved to the operating room for surgical exploration, and damage control surgery with external fixation for articular stabilization (Fig. 3). During surgery, popliteal artery thrombosis was identified. Vascular surgery evaluation determined the limb to be unsalvageable, the patient was later managed with supracondylar amputation (Table 1).

Discussion

Traumatic knee dislocation has been described in association with both high and low-energy mechanisms ranging from motor vehicle collisions to extreme action sports such as martial arts and skiing. Statistically, available literature highlights that anterior knee dislocations have a higher incidence, while posterior dislocations are rare; and always involve rupture of the posterior cruciate ligament [3]. Peripheral nerve injuries and vascular lesions are common collateral damage found in knee dislocations. Nerve injury frequently involves the common peroneal nerve with a reported frequency of common peroneal nerve injury of 10–40 %, with a mean of 26 % across multiple studies [4]. Vascular injury, most commonly popliteal artery injury, includes thrombosis which is reported in 28–46 % of cases. The associated incidence of the popliteal artery and/or vascular aberration is elevated in high-velocity, anterior-posterior knee dislocations [5,6]. With the inherent potential for catastrophic consequences in these injuries, the receiving physician's role during the initial evaluation includes identifying and managing vascular compromise. Failure to properly identify and manage vascular injury after trauma is a major cause of limb amputation and potential morbidity [7]. Most patients (71 %) in which popliteal arterial injury is identified require a revascularization procedure, however, of those patients who do undergo revascularization in the setting of trauma, the amputation rate is 30 % [6].

In this case, the nature of events, delay of definitive treatment, and resource availability at all levels of care directly impacted the outcome of this case. The prolonged delay in definitive care was primarily due to the physical remoteness of the area from which the patient was referred, and also to the significant resource deficiencies that often characterize rural healthcare in developing nations. The ability to care for patients with complex articular injuries in an emergent, resource-deficient scenario is contingent upon various factors such as available resources, including medication, external fixators, staffing, operating room availability, specialist coverage, and access to transport.

A prompt initial assessment is imperative, distal pulses must be measured prior to and immediately after reduction maneuvers. Should any abnormalities be detected during the exam, vascular exploration is indicated with or without the use of angiography intraoperatively. Serial exams should be done to monitor for late-onset complications including popliteal artery thrombosis and compartment syndrome. Pulse exam alone has a reported sensitivity of between 79 % and 91 % for the diagnosis of arterial injury. Angiography is the gold standard for diagnosis of arterial injury, and is highly recommended for thorough evaluation as several patients with normal pulse exams can develop delayed thrombosis secondary to small intimal injuries that are only visible on angiography. However, angiography has been shown to delay care by 2 to 3 h, and should not delay intervention beyond the 6 to 8-h window to avoid critical limb ischemia resulting in amputation. In case of delay and high clinical suspicion, immediate surgical exploration should be prioritized over vascular imaging studies to attempt to salvage the limb. Duplex ultrasound can also be used in this scenario with a sensitivity of 95 % for the diagnosis of vascular trauma [8].

A dislocated knee requires emergent reduction to stabilize the joint and prevent further ischemia and arterial thrombosis, operative intervention is indicated in the presence of open knee dislocation requiring irrigation and debridement, limb-threatening vascular injury necessitating repair, irreducible knee dislocation requiring open reduction, or compartment syndrome fasciotomies [9]. Definitive treatment ideally should be performed subsequently as a second procedure and after careful planning [4].

This patient's delayed presentation to a hospital center equipped with ample resources for thorough evaluation and timely management contributed to the morbidity seen in this case. The prolonged delay in definitive care can be attributed to the remote area from

Fig. 1. Depicts how the patient was received at the Tertiary Care Hospital, findings on arrival, Primary Survey, and portable X-Rays on Secondary Survey.

which the patient was referred, and also to the significant resource deficiencies that often characterize rural healthcare in many developing nations. The ability to care for patients with complex articular injuries in an emergent, resource-deficient scenario is contingent upon various factors including medication, external fixators, staffing, operating room availability, specialist coverage, and access to transport. The training and staffing of rural ED's and hospitals in Mexico differ significantly from urban areas. Rural clinics, ED's, and hospitals are frequently staffed by final-year medical students and occasionally by residents in their final months of training. These critical access hospitals and Emergency Departments are also frequently under-resourced which limits the possibility to provide adequate temporizing measures and definitive care [10–13].

In our case, the patient was transferred to a secondary referral center hours after initially presenting to a rural ED. It was determined by the secondary referral center that the patient was unable to receive the adequate level of care required for a limb and life-saving procedure and therefore transferred to an urban level 1 trauma center (Tertiary Care Hospital) for definitive management. Time-to-first intervention plays a critical role in influencing outcomes for knee dislocation. A reduction of 10 % in the probability of successful salvage for every hour of delay in management has been described in military limb trauma patients with vascular injury, and this relationship between time and salvage rates worsens considerably in the presence of shock [14]. A delay in reperfusion of more

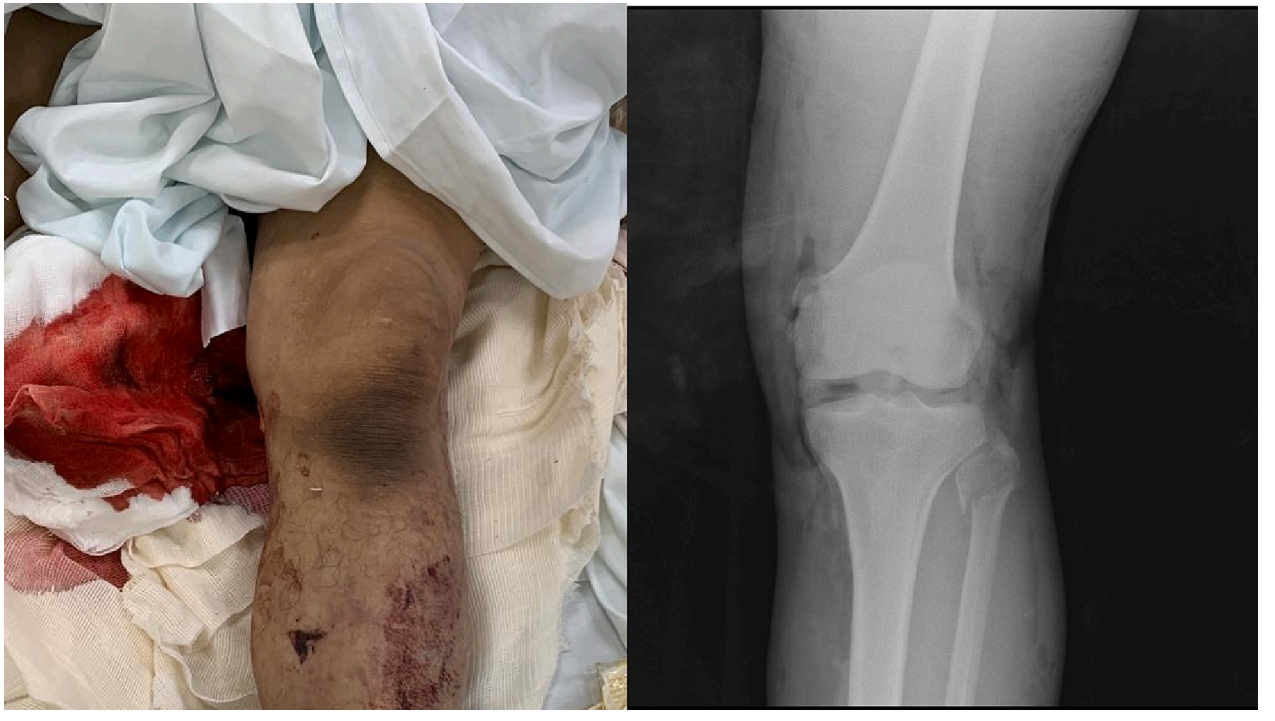

Fig. 2. Depicts the affected limb after reduction in the trauma bay, however, the articulation remained unstable and the patient was ultimately transferred to the OR for irrigation and external fixation.
A) After immediate reduction
B) Portable AP X-Ray Control.

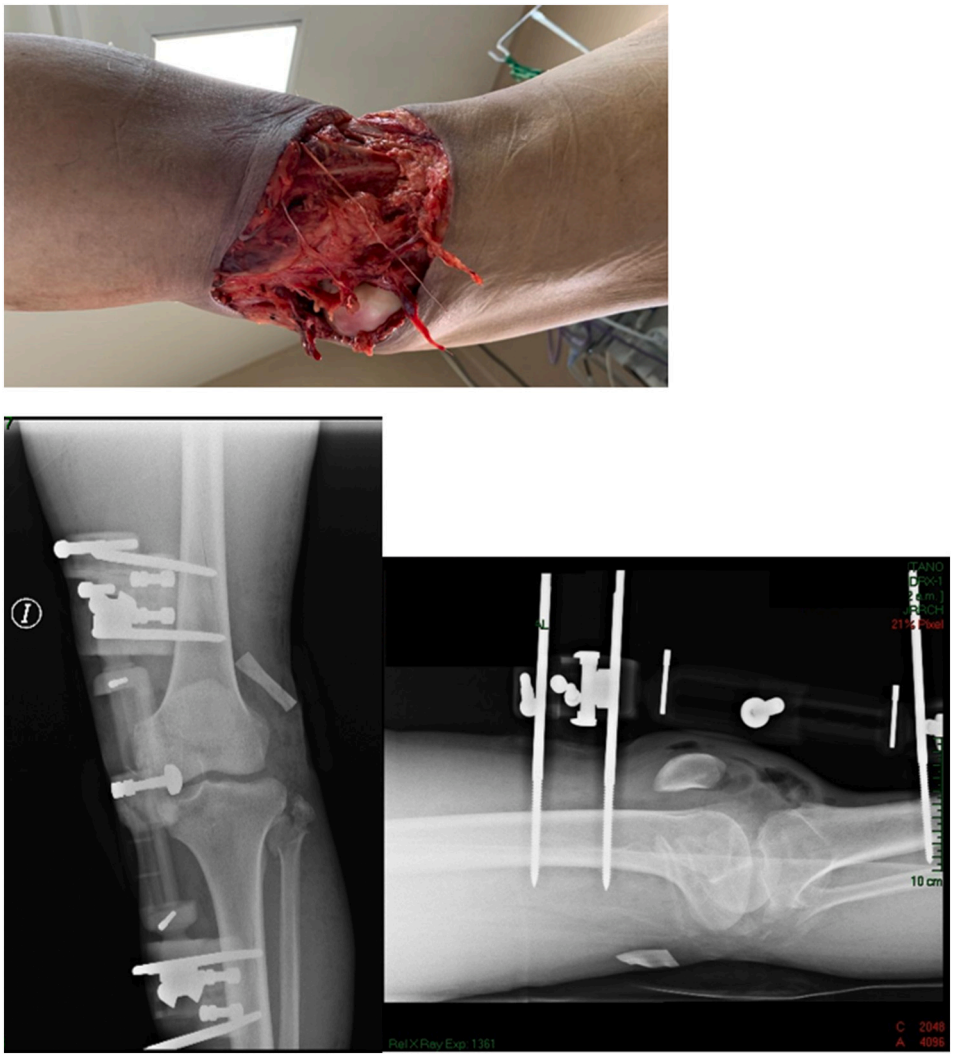

Fig. 3. A) OR Findings, B, C) X-Ray Controls after external fixation.

than 8 h has demonstrated to increase the risk of amputation by approximately 86 % in comparison to 11 % if the limb is re-perfused within 8 h [1,15]. In the event that vascular repair is warranted, the next surgical priority is to stabilize the knee to protect the vascular repair using either a standard above-knee plaster cast or an external fixator [16]. This step is critical, keeping in mind that any concomitant vascular injury can be provoked and further exacerbated by articular instability and multi-ligament injury, increasing the likelihood of complications and unfavorable outcomes [17].

Conclusion

Traumatic posterior knee dislocation is an acute, rare, and potentially life-threatening condition that carries significant morbidity. It is critical to undertake diagnostic and treatment modalities promptly to avoid neurovascular damage, compartment syndrome, and limb amputation. A delayed or missed diagnosis could be disastrous as early intervention with reduction can result in limb-saving and/or lifesaving outcomes. In the setting of traumatic knee dislocation; rapid reduction, assessment of vascular injury, and definitive corresponding treatment are vital to mitigate the possibility of neurovascular damage and long-term sequelae. In this case report, the authors presented a review of literature on the diagnostic work-up and management after knee dislocation, with priority given to several crucial factors that have the greatest influence on the outcome. We also advocate not only for the need for training of peripheral care workers in critical access hospitals for enhanced techniques of trauma management but also for improved resources for temporizing and definitive management, which can help improve critical decision-making upon first contact and minimize complications; as time-to-first intervention defines the post-trauma quality of life for a patient.

Table 1
Previously reported cases of posterior knee dislocation.

Authors	Title	Year	Injury	Intervention	Outcomes	PMID
Martinus Richter et al.	Chronic posterior knee dislocation: treatment with arthrolysis, posterior cruciate ligament reconstruction and hinged external fixation device	1998	Open lower leg fracture with complete dislocation of right knee.	Knee reduction with external fixator following by tibial nailing and quadriceps tendon autograft	Recurrent posterior knee dislocation requiring posterior capsulotomy through a posteromedial incision. PCL reconstruction with an achilles tendon allograft. At one year's follow-up, the patient made a successful recovery.	10193500
Adnan Qamar et al.	Single stage management of chronic posterolateral knee dislocation in a middle-aged man - a case report.	2021	PCL injury along with posterolateral corner instability causing posterolateral knee dislocation	Single-stage arthroscopic reconstruction of PCL followed by open posterolateral corner ligaments reconstruction.	Postoperatively patient had positive functional outcomes.	N/A [doi: 10.29052/IJEHSR.v9.i3.2021.401-404]
Charles E. Cady et al.	An irreducible posterior knee dislocation.	2007	Complete quadriceps tendon rupture with posterior displacement of the patella into the joint space	Emergent open reduction. Postoperative MRI found ACL, PCL, and LCL injury as well as meniscus injury for which he was taken back into the OR for open repair of both ligaments and menisci.	The patient had a somewhat complicated postoperative hospital course and was eventually discharged to a subacute range of motion.	17276836
Vasilios D. Polyzois et al.	A two-stage procedure for the treatment of a neglected posterolateral knee dislocation: gradual reduction with an Ilizarov external fixator followed by arthroscopic anterior and posterior cruciate ligament reconstruction	2016	Posterolateral knee dislocation and a concomitant sciatic nerve injury	A two-stage treatment strategy with gradual reduction using the Ilizarov technique and subsequent arthroscopic anterior and posterior cruciate ligament reconstruction was followed.	The two-stage treatment approach led to a satisfactory clinical outcome. At the latest follow-up evaluation the patient was fully ambulatory and the knee was painless with no anteroposterior instability.	26687927
Kael Duprey et al.	Posterior knee dislocation.	2010	ACL, PCL and LCL tear	Relocation and reduction followed by external fixator	Pt was discharged s/p surgery.	20411095
Francesco Leonardi et al.	Neglected posterior knee dislocation: an unusual case report.	2017	Subluxation and articular diastasis with a concomitant detachment of the apex of the fibular head causing inveterate dislocation of knee	TKA and arthrodesis was offered but the patient declined any surgical procedure.	Not reported	29270565
Slobodan Cvetković et al.	Popliteal artery injury following traumatic knee joint dislocation in a 14-year-old boy: a case report and review of the literature	2021	Traumatic knee displacement with contusion of the popliteal artery following a RTA.	A ruptured posterior cruciate ligament and thrombosed popliteal artery were found on surgical exploration. Resection and saphenous vein grafting was done with transosseous femoral fixation of posterior circuate ligament	Intact arterial perfusion and near normal function of the knee was restored.	24516997
John W. Major et al.	PC176 percutaneous treatment of popliteal artery occlusion after posterior knee dislocation	2017	The study included patients presenting to a tertiary care center within 6 h of the posterior knee dislocation injury having hard signs of arterial insufficiency.	In a hybrid operating room, arterial access was gained and the popliteal artery injuries were traversed. In one patient, this was done antegrade, while in two others, it was done retrograde from distal arterial access. The damaged popliteal lumen was then covered with Viabahn stents, with three-vessel runoff and pedal pulses were palpable in all instances.	Endovascular repair of popliteal artery injury is possible in the case of a posterior knee dislocation. It could result in lower patient morbidity, shorter surgical hours, and faster time to reperfusion.	N/A [doi: https://doi.org/10.1016/j.jvs.2017.03.353]
Robert M. Henshaw	Delayed reduction of traumatic knee dislocation	1996	An unreduced posterior knee dislocation discovered 24 weeks after injury	Open reduction with Steinmann pin fixation followed by a cylindrical cast in extension for 12 weeks, and emoval of pins after 6 weeks.	The limited followup at 22 months had well reduced joint with satisfactory mobility.	8804285

Ethical approval

There was no ethical approval required for reporting this individual case.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

CRediT authorship contribution statement

DM: Conceptualization, drafting, and editing manuscript.
MF: Supervision, review, drafting, editing, and final approval of manuscript.
AB: Drafting manuscript.
ES: Drafting manuscript.
YS: Drafting and editing manuscript.
IP: Organizing, drafting, and editing manuscript.
SC: Final review of manuscript.

Declaration of competing interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgments

None.

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