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Case report of closed reduction of an irreducible postero-lateral knee dislocation and review of the literature

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Summary

Objectives. Knee dislocation is an uncommon injury. This study aims to describe the treatment of a postero-lateral knee dislocation.
Case presentation. We report on a 71-year-old man, who accessed the emergency department for direct-rotational trauma to his left knee. X-rays showed a postero-lateral knee dislocation associated with multiple traction fractures.
Results. Under fluoroscopy a closed reduction was performed in the operating room by flexing the knee to 120°, internal rotation of the lower extremity and valgus stress at the distal thigh. Due to the instability, a knee-spanning external fixation at 30° of flexion was performed. Post-operatively the patient fell, causing disassemblation of the external fixator and recurrence of medial knee dislocation. Only a partial re-alignment was obtained with a second closed reduction and spanning. The knee was later reconstructed with hinged knee prosthesis and the deformity was corrected.
Conclusions. This case report is the third instance of closed reduction for a postero-lateral knee dislocation. Furthermore, this case report highlights possible complications of the treatment of this rare injury and how definitive treatment must be tailored to the patient's age, function, clinical conditions, radiological findings and joint stability.

Key words: knee dislocation, postero-lateral dislocation, irreducible dislocation, closed reduction, knee prosthesis

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Introduction

Dislocation of the knee is an uncommon injury with potential limb-threatening complications to the neuro-vascular bundle. The mechanisms are various, but often involve a hyperextension stress combined with rotational forces due to ultra-low or low energy to high-energy trauma. The incidence is reported to be less than 0.02% but frequency is underestimated because many dislocations reduce spontaneously before the assessment [1]. Acute management includes emergent clinical and radiological neurovascular evaluation followed by closed reduction under conscious sedation, stabilisation and closed neurovascular re-evaluation in order to exclude sequelae of limb ischemia or palsy [2]. Rarely knee dislocations may be irreducible

spontaneously or with closed methods and are usually posterolateral. In these cases, the medial femoral condyle is forced through the knee capsule anteromedially and the subsequent interposition of the medial retinaculum, medial vastus, abductor magnus and/or medial meniscus can create a characteristic "dimple sign". In this situation, the knee cannot be concentrically reduced via traditional manipulation techniques and only few successful attempts of closed reduction with a specific manoeuver have been reported.

Case report

We report the clinical case of a 71-year-old man who presented to the emergency department after a biking incident and a trauma with two main mechanisms: a relatively low energy direct trauma to his left knee and a rotational trauma due to the foot locked on the bike. He came to our attention complaining of pain, complete inability to bear weight and instability of the left knee. Ecchymosis were present on the medial side associated to an invagination of the skin as dimple sign (Fig. 1). Peripheral pulses were present and valid, no sign of hypoperfusion was disclosable, and sensitivity and motor innervation were intact. Neurovascular status and leg and thigh compartments were closely monitored in order to identify any eventual variations. X-rays showed a postero-lateral knee dislocation associated with tibial spine fracture, posterior tibial plate traction fracture and a lateral epicondyle traction fracture at the insertion of lateral collateral ligament. Radiographies also demonstrates an un-displaced fracture of middle third of fibular diaphysis and patella was medially subluxated (Fig. 2). An urgent CT-scan was made to better analyze the bone fragmentation and to exclude any clinically silent neuro-vascular damage. The dislocation could be classified as KN-V on Shenck Classification [2] (Fig. 3).

Two orthopaedic physicians unsuccessfully attempted several attempts at closed reduction under conscious sedation in the emergency department. Traction and counter-traction combined with a direct force to correct the medial deformity of femur were applied, but every attempt failed. Due to the superficial grazes caused by the trauma and the skin condition, and considering the lack of neurovascular bundle involvement, it was not possible to perform an urgent open reduction in the operating room. The patient was placed under transcalcanear traction; sensitivity, motion and peripheral perfusion was strictly monitored. Surgery was planned and scheduled at 48 hours post-trauma under spinal anaesthesia. Open reduction was the alternative if closed reduction failed. Transcalcanear traction was removed in operating room, and the patient was placed supine with a bump under the left hip and was prepared with a sterile field.

Under fluoroscopy a successful closed reduction was performed in the operating room by flexing the knee to 120° combined with internal rotation of the lower extremity and application of valgus stress at the distal thigh as described by Tateda et al.[3] It was manually felt that the manoeuver allowed the medial femoral condyle to be pulled back through the buttonhole in the medial retinaculum. The dimple sign disappeared and reduction was confirmed by fluoroscopy in anterior-posterior and lateral views (Fig. 4). Due to the persistent instability the left lower extremity was placed in a knee-spanning external fixation at about 30° of flexion. Peripheral pulses remained present and valid during and after the procedure; sensitivity and motor innervation were checked post-operatively and were intact. It was planned that the patient would remain in external fixation and non-weight-bearing for 30 days, and then undergo staged ligament reconstruction versus reconstruction with hinged

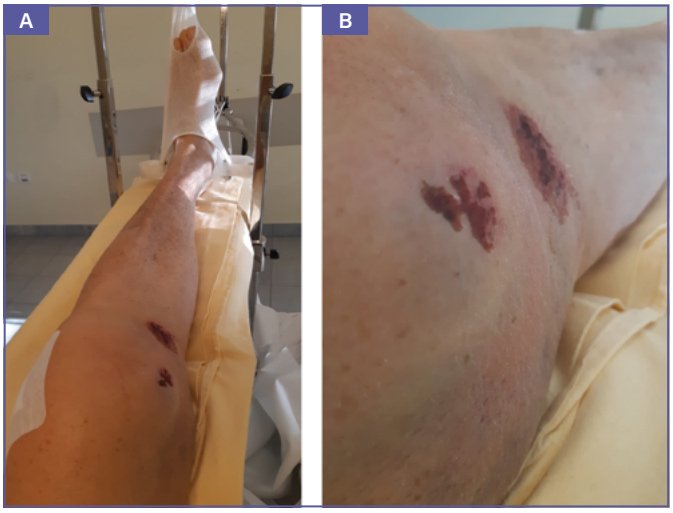

Figure 1. A) clinical picture of the "dimple sign" typical of postero-lateral knee dislocation. Trans-calcanear traction was applied due to the impossibility to perform urgent reduction; B) particular of the dimple sign medial to the knee.

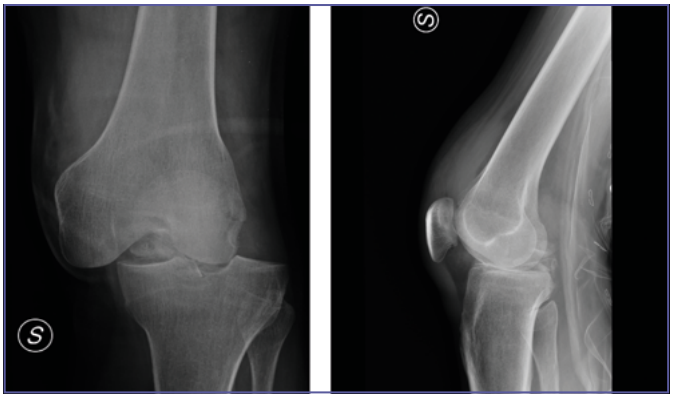

Figure 2. Antero-posterior and latero-lateral view showing the dislocation.

Classification	Description
KD I	Dislocation including disruption of one cruciate ligament (ACL or PCL)
KD II	Dislocation including disruption of both cruciate ligaments only (ACL and PCL)
KD III	Dislocation including disruption of both cruciate ligaments (ACL and PCL) and either collateral ligaments (MCL or LCL)
KD IIIM	Dislocation including disruption of both cruciate ligaments (ACL and PCL) and the MCL
KD IIIL	Dislocation including disruption of both cruciate ligaments (ACL and PCL) and the LCL
KD IV	Dislocation including disruption to both cruciate ligaments (ACL and PCL) and both collateral ligaments (MCL and LCL)
KD V	Fracture-dislocation

Dislocations with associated nerve injury are indicated with "N," and dislocations associated with arterial injury are indicated with "C"; KD = knee dislocation; MCL = medial collateral ligament; LCL = lateral collateral ligament; PCL = posterior cruciate ligament.

Figure 3. Shenck classification (from Goebel CP, Domes C. Classifications in brief: the Schenck Classification of knee dislocations. Clin Orthop Relat Res 2020;478:1368-1372, mod.).

knee prosthesis. On the third post-operative day during hospitalization the patient accidentally fell, causing disassemblation

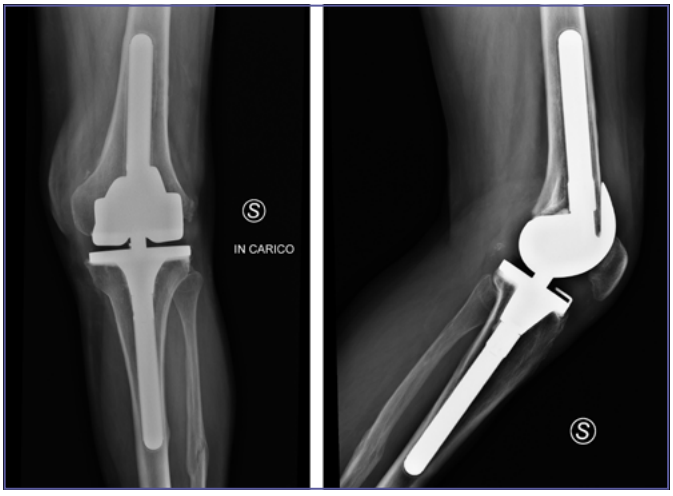

Figure 5. Antero-posterior and latero-lateral view showing the hinged knee prosthesis.

of external fixator and recurrence of medial knee dislocation. Medial buttonholding of distal femur was clearly visible, no signs of neurovascular bundle involvement were present and peripheral pulses were valid. X-rays and CT confirmed the recurrence and excluded neurovascular damages. In operating room a second attempt of closed reduction was performed with the same manoeuver, obtaining only a partial re-alignment with a minimal medial subluxation. Dimple sign was not present after the reduction. Due to the skin condition and the periarticular oedema it was not performed an open reduction and the left lower extremity knee-spanning external fixation was implemented to stabilize the alignment obtained. Peripheral

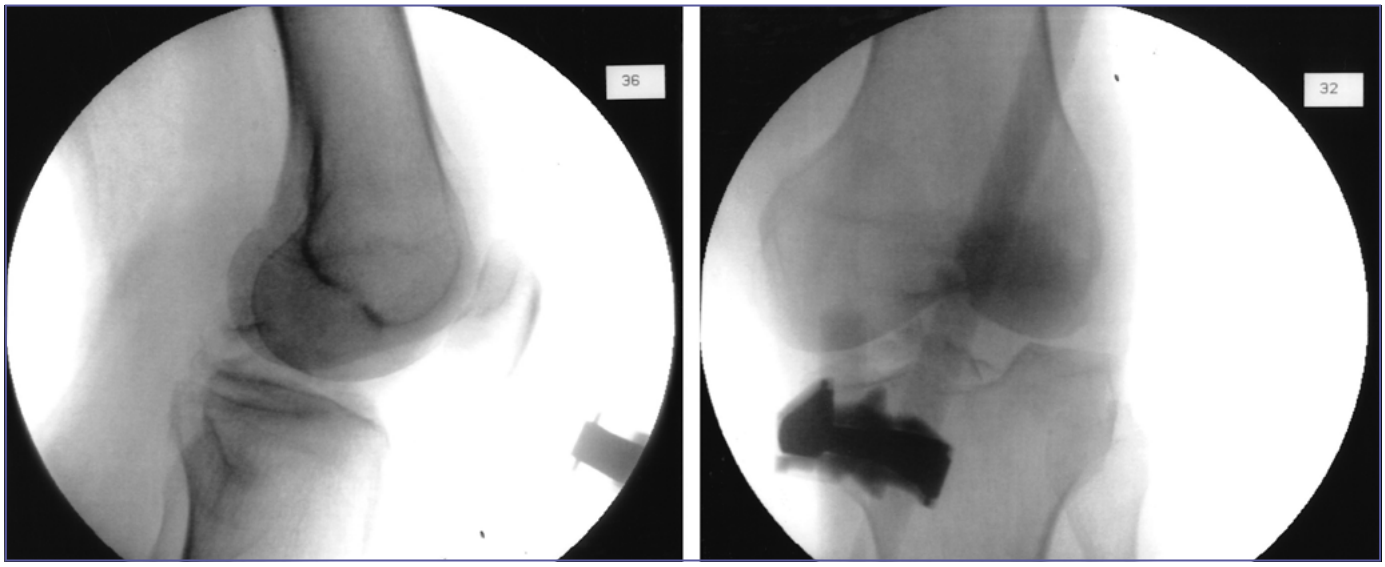

Figure 4. Amplioscopic antero-posterior and latero-lateral view showing the reduction obtained.

pulses, sensitivity and motor innervation were closely monitored post-operatively and no deficits were noticed. The thigh and leg compartments were soft and painless. External fixation and non-weight bearing were confirmed for 30 days. Due to the age of the patient, joint conditions and due to the instability derived from dislocation and traction fractures, a reconstruction with hinged knee prosthesis was planned.
At the removal of the external fixator the knee was reconstructed with hinged knee prosthesis and the deformity was corrected. The stability and function were good and no complications were reported. There were no mechanical failures at two years of follow-up.
The patient's written informed consent was collected before the drafting of the present manuscript.

Discussion

Dislocations of the knee are rare and account for less than 0.02% of orthopaedic injuries, but are likely under reported due to spontaneous reduction before assessment and to misdiagnosis [1]. Rotational dislocation accounts for 4% of knee dislocations and lateral dislocation can cause an entrapment of medial soft tissue. The button-holding of the medial femoral condyle and the traction of medial structure on skin cause medial ecchymosis and a wrinkly depression called a dimple sign, which is typical of irreducible dislocations. Medial retinaculum and MCL are the most commonly entrapped structures, but also the interposition of medial vastus, abductor magnus and medial meniscus can render a spontaneous or a closed reduction impossible. Close evaluation of peripheral perfusion and sensitivity and radiological examination of vascularization are mandatory due to the high incidence of popliteal artery and common peroneal nerve injury, respectively reported at 16% and 20-40% [2]. Historically, treatment was open reduction but recently a few successful attempts of closed reduction have been reported [3,4].
The historical classification of knee dislocation created by Kennedy is based on the direction of tibial displacement and has five categories: anterior, posterior, medial, lateral, and rotatory [2]. The spontaneous reduction of a large part of knee dislocations is the main limit to this classification; more recently, Schenck categorised knee dislocations based on the pattern of ligamentous injury demonstrated by MRI [2]. Five patterns are described, from single ACL or PCL injury in grade 1 to complete collateral and cruciate ligamentous disruption associated with periarticular fracture in grade 5 [5] (Fig. 3).
Historically, knee dislocations were considered rare entities and a consequence of high-energy trauma commonly seen in road accidents, but several reports and higher diagnostic suspicion and capacity have brought to reconsideration of trauma mechanisms including low-energy trauma [4] and trauma during contact sport activity or high impact activity. Very often knee dislocations spontaneously reduce before assessment and only anamnesis and clinical suspicion can guide diagnosis [2]. Excluding injuries to the neurovascular bundle is mandatory because of the high risk of popliteal artery and peroneal nerve lesion [5]. The popliteal artery segment between the two fixation points of abductor hiatus and soleus arch is endangered: posterior dislocations have a higher risk of complete popliteal artery tear, anterior dislocations have high risk of subclinical intimal tear due to a traction mechanism, and lateral and rotational dislocations have a lower risk of vascular damage. The presence of peripheral pulses exclude a major arterial damage, but is often insufficient to diagnose an intimal tear. Ankle-brachial index (ABI) is a good clinical tool to exclude vascular involvement, but in case of clinic suspicion angio-CT is nowadays the gold standard and have supplanted angiography [2]. The common peroneal nerve segment tethered between the fibular neck proximally and the intermuscular septum distally is extremely vulnerable to injury in knee dislocations due to traction mechanism, with an incidence reported up to 40% [2]. Peroneal nerve injury is most commonly associated with posterior cruciate ligament disruption and with anterior dislocation. Complete recovery is related to the entity of nerve damage and only 50% of patients regain complete function.
Only a small proportion of knee dislocations can be classified as irreducible and usually the tibia is translated postero-laterally. Classical reduction manoeuvers fail because of the button-holding of medial femoral condyle through the medial capsule and the entrapment of medial soft tissues. Traction of these structures on skin creates a typical wrinkly depression called "dimple sign", historically considered a contraindication for closed reduction. Medial retinaculum and medial collateral ligament are the most common obstacles to reduction, but articular capsule, medial meniscus, medial vastus and abductor magnus can also be involved. Usually postero-lateral dislocations have multiple ligamentous involvement and are classifiable as type 3 or major in Shenck's classification [2] (Fig. 3). The vascular injury rate is lower than other types of dislocations and damage to the common peroneal nerve is relatively frequent.
Usually, classical manoeuvers for closed reduction are unsuccessful and repeated attempts can worsen the skin condition because of the traction of soft tissues. Some authors have reported arthroscopic reduction attempts, but only a few had success [2]. Tateda et al. [3] first described a closed reduction technique that consists in flexing the knee to 120° along with internal rotation of the lower extremity and applying a valgus force at the distal thigh. The manoeuver was intended to recreate the mechanism of dislocation, reducing the medial distal femur through medial soft tissue. This reduction technique was successfully used by Schmicker and colleagues [4], which further stabilises the articulation with knee-spanning external fixation. In both case reports, as in this case, preoperative MRI was not obtained and it was not possible to identify the medial structure interposed which made the dislocation irreducible. Despite this, we confirm the effectiveness of the manoeuver in reducing postero-medial dislocations. The attempt of reduction

of the relapse was not completely successful probably due to articular oedema and the early reparative processes of bone and ligament disrupter, although this technique allowed restoration of satisfactory alignment of the knee.
Urgent open reduction and neurovascular assessment continue to be the main treatment for postero-lateral knee dislocation with good prognosis [5]. In cases of determined absence of neurovascular injury, the technique described by Tateda et al. [3] can be an alternative to urgent surgery. After reduction, immobilisation is necessary due to the intrinsic instability caused by the trauma and ligament disruption. Bracing can be used in minor ligament injury, while gross instability requires a solid immobilisation usually obtained with external fixations.
Early ligament repair versus late reconstruction is still matter of debate as well as the timing of reconstruction, but much depends on patient's clinical conditions, needs for emergent vascular surgical management, skin and soft tissue condition, grade of ligament lesion and bone stock [2]. Hinged prosthetic reconstruction can be considered in case of major ligament damage associated with gross instability in elderly patients in which reconstruction would not guarantee complete articular restoration and to ensure a faster post-traumatic recovery.

Conclusions

Knee dislocations are uncommon and postero-lateral knee dislocations are rare. This type of dislocation is historically defined as irreducible and is characterised by unsuccessful attempts of closed reduction with conventional manoeuvers due to interposition of medial soft tissue structures, wide medial joint space on plain radiographs and the dimple sign [3]. Open reduction my be required due to the impossibility to acutely reduce the dislocation with classical manoeuvers and the high risk of neurovascular injury requires prompt evaluation and eventual emergency treatment.
Tateda et al. [3] described a successful attempt of closed reduction and this technique was recently used with efficacy by Schmicker and colleagues [4]. The realignment of joint heads and regularisations of articular space width on plain radiographs and the disappearance of the dimple sign typically prove the success of closed reduction. This case report is the third instance of closed reduction of a postero-lateral knee dislocation, using knee flexion flexing 120° combined with internal rotation of the lower extremity and the application of a valgus force to the distal thigh. The same technique was applied on the recurrence succeeding in withdrawal the medial femoral condyle through medial soft-tissue structures. Due to gross instability and the high grade ligamentous damage a stabilization with external-fixation was used along with prosthetic reconstruction with good functional results at 2 years of follow-up (Fig. 5).
Additional reports and evidence is needed to validate of this technique and further studies about the outcomes are warranted to evaluate its safety and effectiveness.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

MF: writing and editing the manuscript; MR: editing and reviewing figures and manuscript; AV: reviewing the manuscript; CI: writing and reviewing the manuscript.

Ethical consideration

An informed consent to the publication of clinical history, radiological images and medical conditions and treatment relative to the present case report, was signed by the patient after an extended information made by medical doctors.

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