

Radiological assessment of irreducible posterolateral knee subluxation after dislocation due to interposition of the vastus medialis: a case report

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Abstract Knee dislocation is a serious and relatively uncommon traumatism that every emergency room is supposed to diagnose and treat rapidly. Most of the time these dislocations reduce spontaneously or with closed reduction. If a subluxation persists, an incarceration of soft tissue in the joint must be suspected. Irreducible knee subluxations after dislocation are rare entities better described in the orthopaedic than in the radiological literature. However, the initial radiological assessment is an important tool to obtain the correct diagnosis, to detect neurovascular complications, and to plan the most suitable treatment. In cases of delayed diagnosis, the functional prognosis of the joint and even the limb may be seriously compromised primarily because of vascular lesions. Thereby, vascular imaging is essential in cases of dislocation of the knee, and we will discuss the role of angiography and the more recent use of computed tomography angiography or magnetic resonance angiography. Our patient presented with an irreducible knee subluxation due to interposition of the vastus medialis, and we will review the classical clinical presentation and ‘do not miss’ imaging findings on conventional radiography, computed tomography angiography, and magnetic resonance imaging. Finally, we will also report the classical imaging pathway indicated in knee dislocation, with a special emphasis on the irreducible form.

Keywords Irreducible knee dislocation · Vastus medialis

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Introduction

Posttraumatic irreducible knee subluxations after dislocation are rare and severe entities that require early care for both initial assessment of lesions and planning of orthopaedic treatment [1, 2]. Moreover, sequelae after knee dislocation significantly reduce the functional prognosis of the joint and consequently the quality of life for patients [3]. Their irreducibility is most often secondary to incarceration of capsular, ligamentous, or muscular structures within the joint space [4]. In the case of posterolateral dislocation, the structures usually involved are the medial meniscus, capsule, medial collateral ligament, and vastus medialis [4].

Neurovascular lesions are also frequent and essential to depict [3]. Arterial injury management depends on the severity of the lesion and the different treatments range from nonsurgical options to bypass vascular surgery [5]. An untreated popliteal lesion increases the risk of amputation and must be detected and treated rapidly [6]. Damage to the common peroneal nerve must be evaluated by clinical examination and by electromyography in the medium term if any doubt persists [7].

We report one case of such irreducible posterolateral subluxation after dislocation of the knee due to interposition of the vastus medialis and review the classical clinical aspect and ‘do not miss’ imaging findings on conventional radiography, computed tomography angiography, and MRI (magnetic resonance imaging). Knowledge of the imaging pathway and features is necessary to correctly diagnose these cases and identify neurovascular complications that significantly worsen the functional outcome.

Materials and methods

Our patient is a 54-year-old male with no relevant past medical or surgical history who fell and twisted his right knee

while skiing. Pain and total impotence resulting from trauma required the patient to be transferred to our hospital for the management of a suspected posttraumatic dislocation of the right knee.

The clinical examination was immediately performed in the emergency room by an orthopaedic surgeon. Then the patient sequentially underwent anteroposterior and lateral conventional radiographs, computed tomography angiography of the lower limbs, and MRI of the right knee. The patient was finally treated by open surgery for reduction and stabilisation.

Results

On arrival, the patient presented considerable swelling of the right knee, with medial cutaneous incarceration (Fig. 1), known as a ‘dimple sign’ [4]. The mobility was limited with knee flexion at 50° and impossibility of flexion/extension movements. There was no detectable neurovascular disorder. Peripheral pulses, skin colour, and local temperature were symmetric in both legs. Sensibility was normal and motor



Fig. 1 A 54-year-old male suspected of posttraumatic irreducible knee subluxation after dislocation. Preoperative photography illustrates the characteristic ‘dimple sign’

function seemed to be limited only by the flexion and pain, without a suspected neurological deficit.

Anteroposterior and lateral conventional radiographs (Fig. 2) showed a discrete avulsion of the lateral femoral condyle, suggesting a ligamentous tear of the lateral collateral ligament, an enlargement of the medial femorotibial space, an important effusion, and a medial soft tissue attraction.

Computed tomography angiography with contrast injection in the arterial phase (Fig. 3) excluded arterial injury associated with the dislocation. Finally, magnetic resonance imaging (Figs. 4, 5 and 6) proved vastus medialis partial incarceration within the intercondylar notch, associated with medial femorotibial trapping of the medial patellofemoral ligament, capsule, and subcutaneous tissue. Associated ligamentous tears included complete rupture of the anterior and posterior cruciate ligaments as well as internal and external collateral ligaments.

Less than 24 h after the patient's arrival, all of the imaging described above was performed and the patient underwent surgical reduction by parapatellar medial arthrotomy (Fig. 7). At the same time, stabilisation of the knee was provided by reinsertion of the medial patellofemoral ligament, posterior oblique ligament, and medial collateral ligament. Cruciate ligament surgery was not undertaken for this patient.

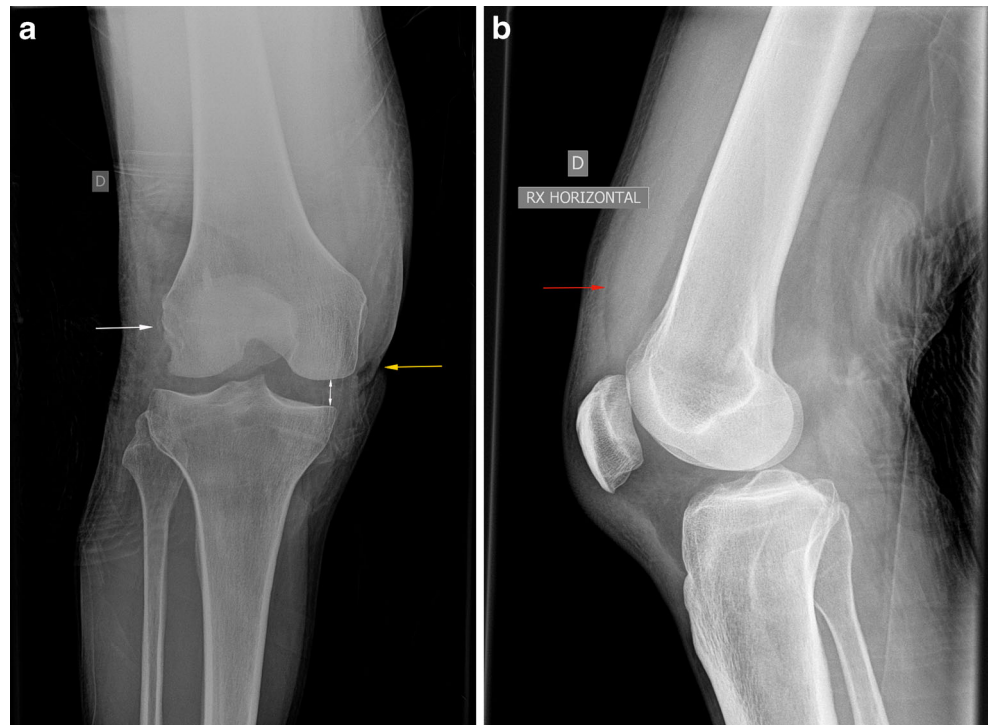
The patient evolved favourably and was discharged from the orthopaedic unit 15 days after surgery. Consultation controls with oral interview and clinical examination at 6 weeks, 3 months, and 6 months confirmed this favourable evolution in terms of healing, pain, joint stability, and passive and active range of motion. The patient resumed his normal professional and extra-professional activities less than 1 year after the accident.

Discussion

Knee dislocation is defined as a complete loss of femorotibial congruence and subluxation as a disruption, with parts of the articular surfaces remaining in contact [3, 7]. The classifications are based on the tibial displacement or on the pattern of ligament injury. The tibial displacement may be anterior (40 %), posterior (33 %), lateral (18 %), medial (4 %), or rotatory (5 %) [4, 8]. Later, Schenck et al. [9] proposed a more biomechanical classification, using the pattern of ligament injury, and this classification has finally been modified by Wascher et al. [10] to include associated lesions as vascular, neurological, or osseous. This modified Schenck classification is the most commonly used in clinical practice.

Posttraumatic knee dislocations are rare and generally reduced spontaneously or by a closed method. Most of the time, their irreducibility is associated with interposition of soft tissue structures such as the medial meniscus, capsule, retinaculum, and vastus medialis in posterolateral dislocations

Fig. 2 Anteroposterior (a) and lateral (b) conventional radiographs show a discrete fracture of the lateral femoral condyle (*white arrow*), enlargement of the medial femorotibial space (*double-headed white arrow*), a medial soft tissue attraction (*yellow arrow*), and an important effusion (*red arrow*)

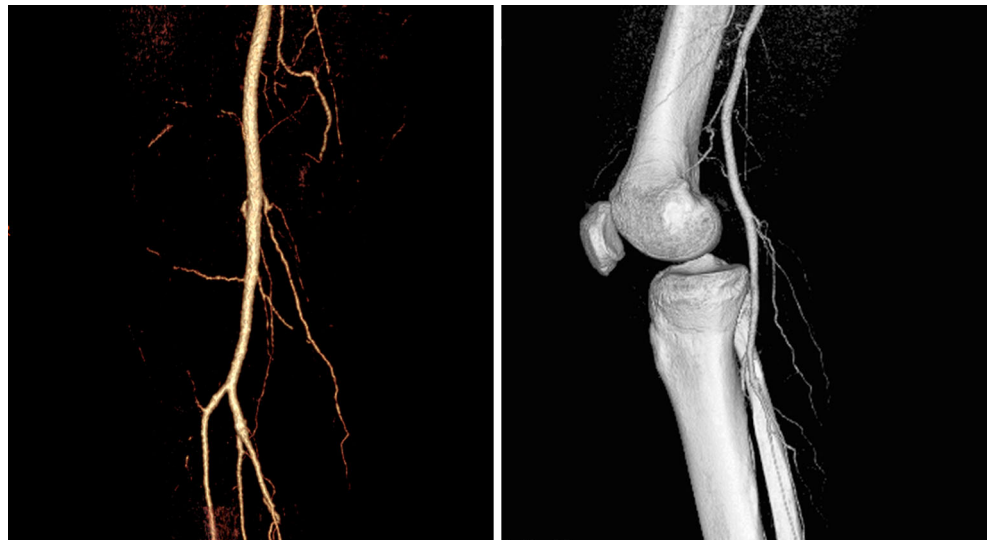


[11–13]. The mechanism implicated in a posterolateral dislocation can be high, low, or sometimes very low energy trauma [3, 14] and is usually secondary to valgus and internal rotation of the tibia.

Clinically, the most specific sign of an irreducible subluxation after dislocation seems to be the ‘dimple sign’ suggesting the interposition of medial structures [4]. However, clinical evaluation of knee dislocation patients is difficult most of the time because of the pain and, eventually, other life-threatening injuries. American College of Radiology criteria summarise the clinical parameters necessitating realisation of

radiographic views of the knee after acute trauma as joint effusion within 24 h, palpable tenderness over the fibular head or patella, inability to walk or bear weight, inability to flex the knee to 90°, and altered mental status [15]. Radiographic signs of irreducible subluxation after dislocation are subtle and include misalignment of the femur and tibia as well as the enlargement of the femorotibial joint without gross dislocation. These signs as well as the radiographic ‘dimple sign’ corresponding to the clinically visible attraction of the soft tissues can easily be missed and should be looked for carefully in case of clinical suspicion.

Fig. 3 Computed tomography angiography with 3D reconstructions excludes injury of the popliteal artery



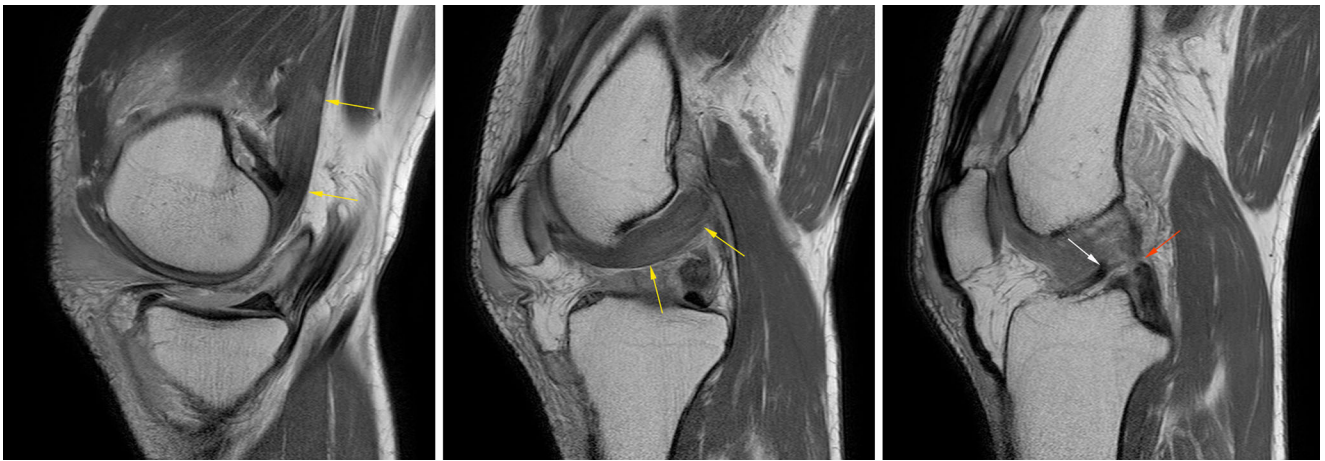


Fig. 4 Sagittal proton density-weighted images confirm incarceration of the vastus medialis muscle in the intercondylar notch area (yellow arrows) and complete rupture of anterior (white arrow) and posterior (red arrow)

cruciate ligaments. Note the wrapping of the muscle around the distal femur

MRI for these patients was proved to be more accurate in the assessment of soft tissue damage, in particular ligamentous injuries [16]. Associated injuries of the menisci, cartilage, bone, and capsule or other soft tissue damage can also be easily described. The ‘dimple sign’ corresponding to the medial condyle buttonholing through soft tissues described clinically is shown by MRI on coronal views [17].

For any type of knee dislocation, vascular injury has to be quickly and carefully searched for due to the risk of amputation, which may increase to 86 % in case of treatment delay of more than 8 h [6]. Arterial injury concerns the popliteal artery and is reported in about 30 % of knee dislocations. This elevated rate is probably due to the poor collateral arterial pathway and to its proximal and distal fixed attachments above the knee at the adductor hiatus and below the joint behind the soleal arcade [7]. The artery may present any type of injury, from transient abnormality by kinking or time-limited occlusion to dissection, thrombosis, and transection.

Physical examination must include observation of colour and temperature and palpation of the dorsalis pedis and posterior tibial arteries. The absence of pulses, presence of bruit or thrill, and presence of ischaemic signs or active haemorrhage seem to be 100 % accurate for determining the need for surgical exploration. The ankle brachial index is another simple and noninvasive tool for assessing vascular perfusion. It corresponds to the ratio of the systolic ankle pressure to systolic arm pressure. An ankle brachial index of >0.9 was also proved to be 100 % accurate in excluding vascular injury [18].

If this clinical assessment is clearly pathological, surgery is advocated, but the good practice for an asymptomatic patient remains controversial, since secondary clotting on an intimal lesion and a complete lesion with peripheral normal pulse were described [19–21]. Most authors consider that vascular imaging remains justified in this serious traumatic context [22–24], but the historical invasive angiogram is progressively being replaced by computed tomography angiography [7, 15,

Fig. 5 Coronal T1 spin echo-weighted image (a) and coronal short tau inversion recovery-weighted image (b) show tears of both internal (yellow arrow) and external (red arrow) collateral ligaments. Note the focal bone contusion (white arrow) corresponding to the fracture described on the conventional radiograph. The medial meniscus has a normal feature





Fig. 6 Axial fat-suppressed proton density-weighted image with intercondylar trapping of the medial patellofemoral ligament (*white arrow*) and the vastus medialis (X)

25]. This technique decreases the rate of complication by its noninvasive feature and is demonstrated to be as accurate as arteriography in the diagnosis of traumatic arterial injuries [26, 27]. Moreover, knee dislocation may be associated with other injuries in case of polytraumatised patients, for whom exploration by computed tomography is better.

The advantage of magnetic resonance angiography is that the examination can be done at the same time as MRI for soft-tissue injury diagnosis and it correlates 100 % with angiogram findings in multiple ligament knee injuries [28]. The problem with magnetic resonance angiography remains its accessibility and the long acquisition time, during which the patient must remain still. If ligament stabilisation is not considered, and if

the examination is not associated with MR angiography, MRI for the assessment of structural damage could be delayed. Finally, the current recommended approach is to propose immediate vascular noninvasive imaging by computed tomography angiography or magnetic resonance angiography.

Similarly, the common peroneal nerve is injured in 20–30 % of cases of knee dislocation [29] because of stretching or rupture caused by traction. The initial assessment is clinical and by MRI because electromyographic changes are not present in the first weeks after injury [7, 30].

In case of irreducibility, the patient requires prompt treatment by open surgery. After reduction, the treatment remains controversial but the literature describes better outcomes for surgical stabilisation of ligamentous tears compared with conservative treatment, while the timing of these reconstructions remains variable [31, 32]. A recent prospective study [33] suggests that open dislocations and vascular disease should be surgically treated in emergency, without associated ligament reconstruction. In other cases, ligament stabilisation would be an option for patients under 60 years of age.

The irreducible knee subluxation after dislocation with interposition of musculo-ligamentous structures is rare but its clinical appearance and orthopaedic management are well described because of the functional risk to the joint and even the limb. Radiological assessment is also an important part of the management, in the diagnosis, description of implicated structures, and functional prognosis prediction. Radiographs are the first necessary step to diagnose subluxation and to exclude associated fractures. Vascular imaging is imperative in the management of these patients as the prognosis is closely related to the presence of vascular complications, and progressively, noninvasive imaging such as computed tomography and magnetic resonance angiography are replacing conventional angiography. MRI allows the study of vascular and soft tissues at the same time but is not readily available in all emergency centres.

Conflict of interest The authors declare that they have no conflict of interest.

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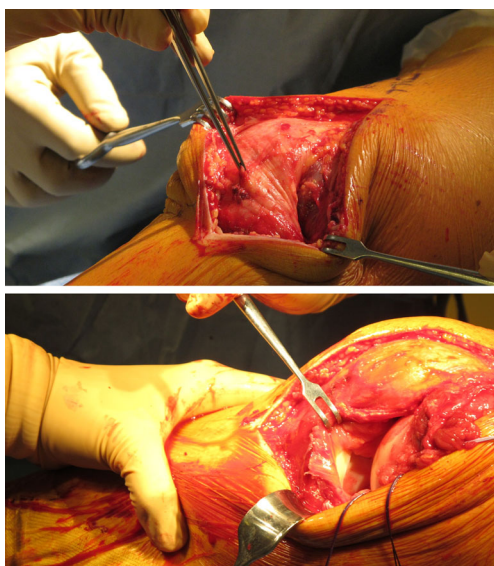


Fig. 7 Peroperative photographs. Medial parapatellar arthrotomy allows good visualisation of muscular incarceration

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