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## Case Report

# Intra-articular elevating osteotomy for tibial plateau fracture malunion with intra-articular depression: Surgical technique and review

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## ABSTRACT

Open reduction with internal fixation is the gold standard treatment for tibial plateau fractures. However, some complications can be observed despite a well-established procedure. Apart from stiffness, malunion is the most frequent complication of tibial plateau fractures.

These malunions may be intra-articular or extra-articular or combined.

Intra-articular or extra-articular osteotomy is a good option to treat malunion in young and active patients without significant joint damage. When malunion is associated with extensive joint involvement or the initial cartilage damage has resulted in knee osteoarthritis, the surgical option is a total replacement of the knee joint with arthroplasty.

We report the case of a patient with a tibial plateau fracture treated initially at a traditional bonesetter complicated at the end of the treatment with the persistent of the knee pain and limping.

## Introduction

Tibial plateau fractures constitute 1 % of all fractures. The peak of incidence is observed in young patients following high energy traumas or in elderly patients with osteoporotic bone [1]. The most used classification for these fractures is the Schatzker classification described initially in 1979 [2].

Due to the articular character of the plateau tibial fractures, the gold standard treatment is based on an open reduction and restriction of the joint congruence associated to a stable osteosynthesis (Plate, screws) allowing an early mobilisation. However, in some cases with important soft tissue damage, external fixator can be considered [3]. A lot of studies reported multiple complications that can be observed in this type of fractures: Knee stiffness, infection, malunion, non-union and post-traumatic osteo-arthritis [4].

Malunion can be intra-articular or extra-articular or combined. It can be the result of nonoperative treatment or operative treatment with a non-anatomical reduction [5]. The rate of post-traumatic osteoarthritis has been poorly established in the literature reviews: Honkonen reported the development of secondary osteoarthritis in 44 % of cases at mean follow-up of 7,6 years [6], Marsh

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et al. found 23,8 % cases of post-traumatic arthrosis in a study of 21 tibial plateau fractures [7].

The main goal of management of the malunion is to restore the joint articular congruence and correct the axis in order to prevent or delay the knee osteoarthritis. A lot of treatments have been described in literature review: Intra-articular osteotomy, extra-articular osteotomy, combined intra-articular and extra-articular osteotomy, unicompartamental knee arthroplasty and total knee arthroplasty [8]. The choice of the technique depends on the age of the patient, the joint damage, the type of malunion (Intra or extra-articular), the degree of depression, axis deformity [9].

We report the case of a patient with a tibial plateau fracture treated initially at a traditional bonesetter complicated at the end of the treatment with the persistent of the knee pain and limping due to the presence of an intra-articular malunion depression of the lateral tibial plateau.

The patient was informed that data concerning the case would be submitted for publication, and he provided consent.

## Case report

A 30 years old female patient with no medical or surgical history. The patient was victim a year ago of a fall in the stairs and reception on her left knee causing her pain and total functional impotence, the reason why the patient consulted in a hospital structure where standing radiographs disclosed an external tibial plateau fracture and a surgical treatment was indicated for the patient. The patient refused surgery and preferred a traditional bonesetter treatment with a cast for 5 to 6 weeks.

Patient was seen for the first time in our structure 14 months after her fracture and presented with a growing pain of the left knee and limbing.

Physical examination revealed a valgus deformity (Fig. 1) of the left knee with left quadriceps amyotrophy (Fig. 2).

Range of motion of the left knee was normal both actively and passively. The palpation of the lateral compartment of the knee was painful.

The clinical examination found no laxity and no signs in favor of a meniscal lesion.

Radiographs revealed a malunion of the external tibial plateau with an important intra-articular depression (Fig. 3). The Joint Line Convergence Angle, or JLCA angle, was measured to  $5,7^\circ$  and the intra-articular depression of the external tibial plateau was measured to 11 mm (Fig. 4).

Computed tomography (CT) showed that the intra-articular depression was located in the central and anterior part of the proximal lateral tibial cortex (Fig. 5).



Fig. 1. Valgus deformity of the left knee.

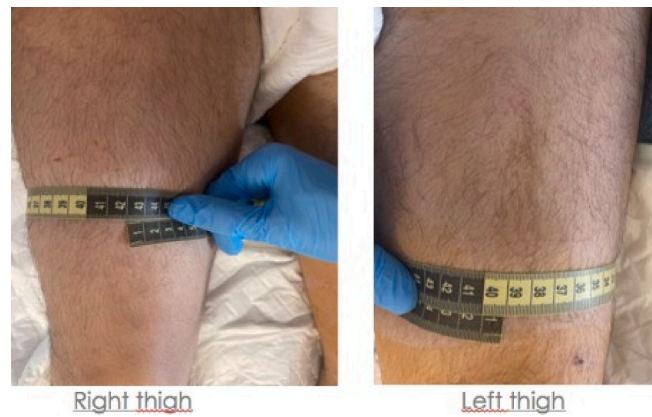


Fig. 2. Left quadriceps amyotrophy.

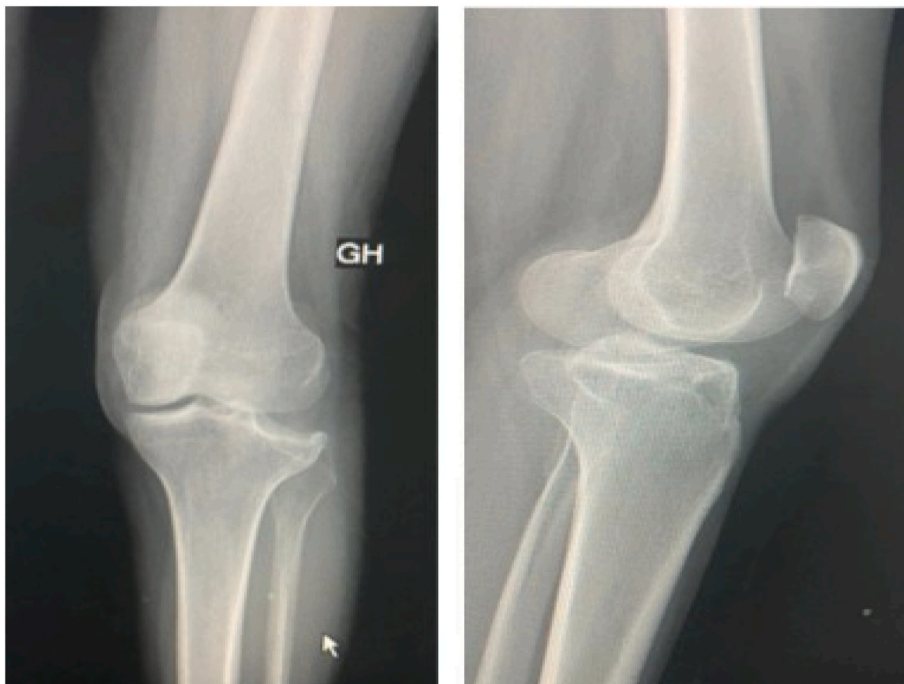


Fig. 3. Radiographs revealed a malunion of the external tibial plateau with an important intra-articular depression.

Given the young age of the patient (30 years old), the importance of the clinical symptoms (Pain, limbing), the degree of the depression (11 mm), the absence of signs in favor of osteoarthritis of the medial compartment and femoro patellar compartment of the knee, no findings in favor of meniscal or ligamentous injury associated, a conservative treatment was proposed to the patient based on an intra-articular osteotomy of the lateral tibial plateau which is going to elevate the depression and correct the intra-articular congruence.

Patient was admitted to the OR, under general anesthesia, in a dorsal decubitus position with the knee flexed to 30°.

The approach was through a midline knee incision that was followed by a lateral parapatellar approach with a iliotibial tract tenotomy. The exploration found no meniscal tear or lesion associated. A sub-meniscal arthrotomy was then performed for a better visualisation and control of the depression (Fig. 6). An open-book osteotomy of the lateral tibial plateau was executed: Initially, a 2 cm long vertical osteotomy was performed with the oscillating saw, entering the knee joint just lateral to the lateral tibial spine, and continuing distally to a level just proximal to the tibial tubercle (Fig. 7).

The articular cartilage was then separated, along with an approximately 10-mm-thick block of subchondral bone, with a small osteotome. The osteotomy was completed with a horizontal limb, commencing from the distal edge of the initial vertical osteotomy and heading in a posterolateral direction.

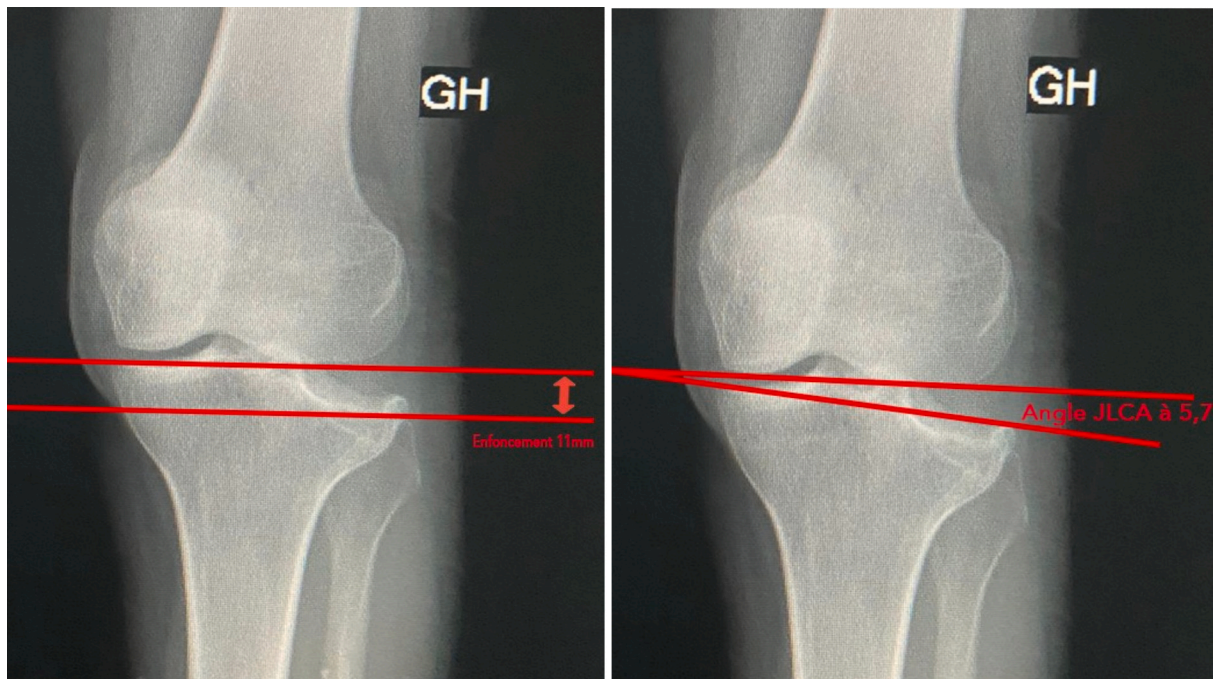


Fig. 4. JLCA angle, was measured to 5,7° and the intra-articular depression of the external tibial plateau was measured to 11 mm.

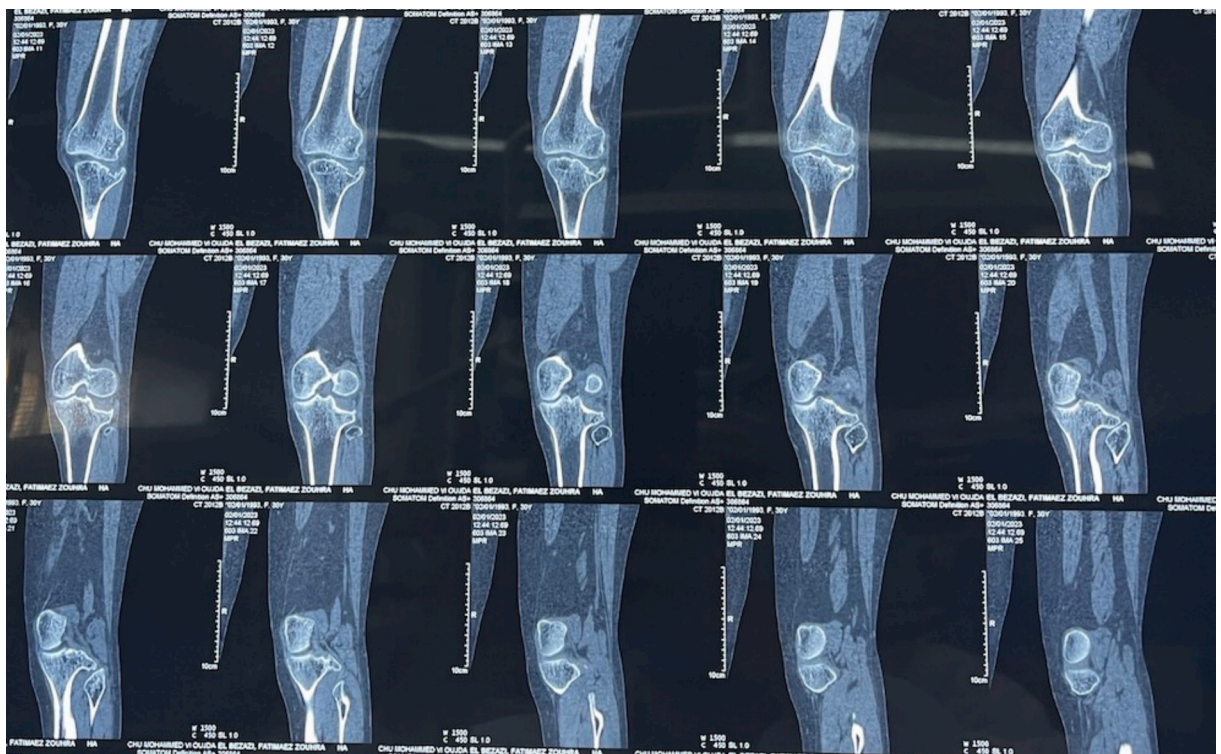


Fig. 5. CT scan showing the depression intra-articular.

The articular surface and the subchondral bone block were then elevated to a satisfying level, and the resulting void was filled with a bone graft (Fig. 8). The open book was then closed, and the whole construct was stabilized with a lateral plateau plate in T shape. The post-operative JLCA angle was corrected and measured to 2,1° (Fig. 9).

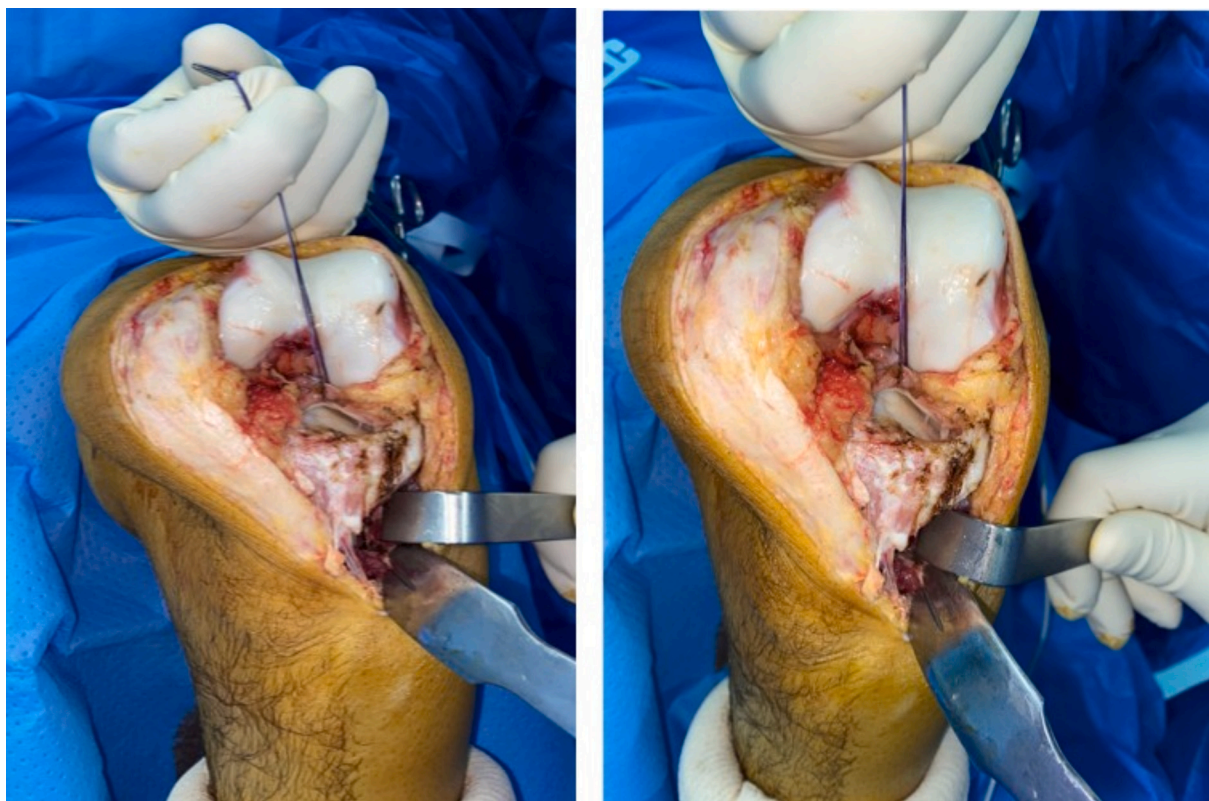


Fig. 6. Intraoperative image showing the sub-meniscal arthrotomy.

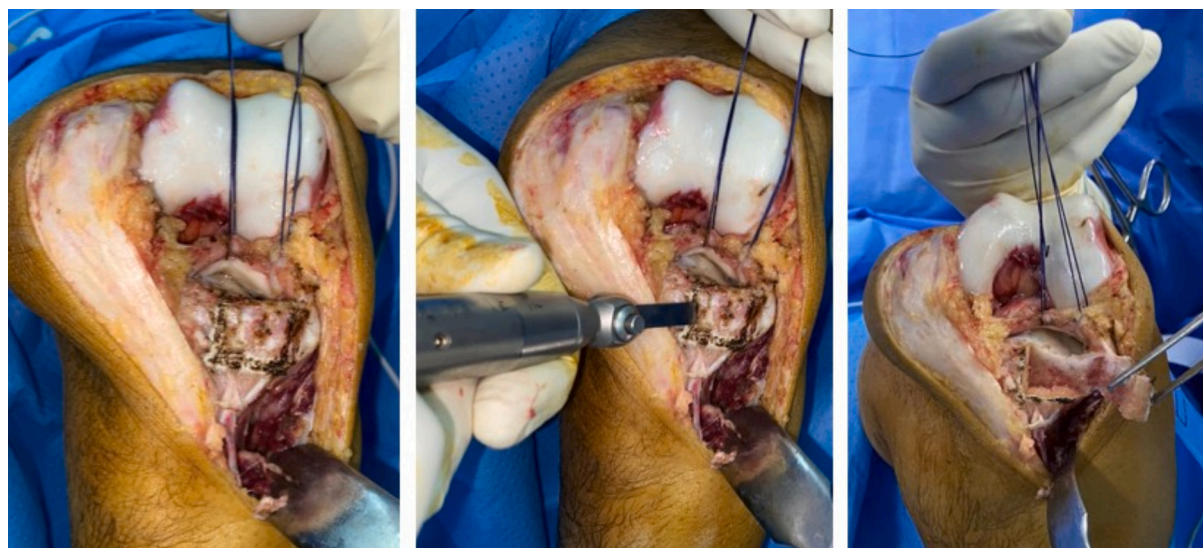
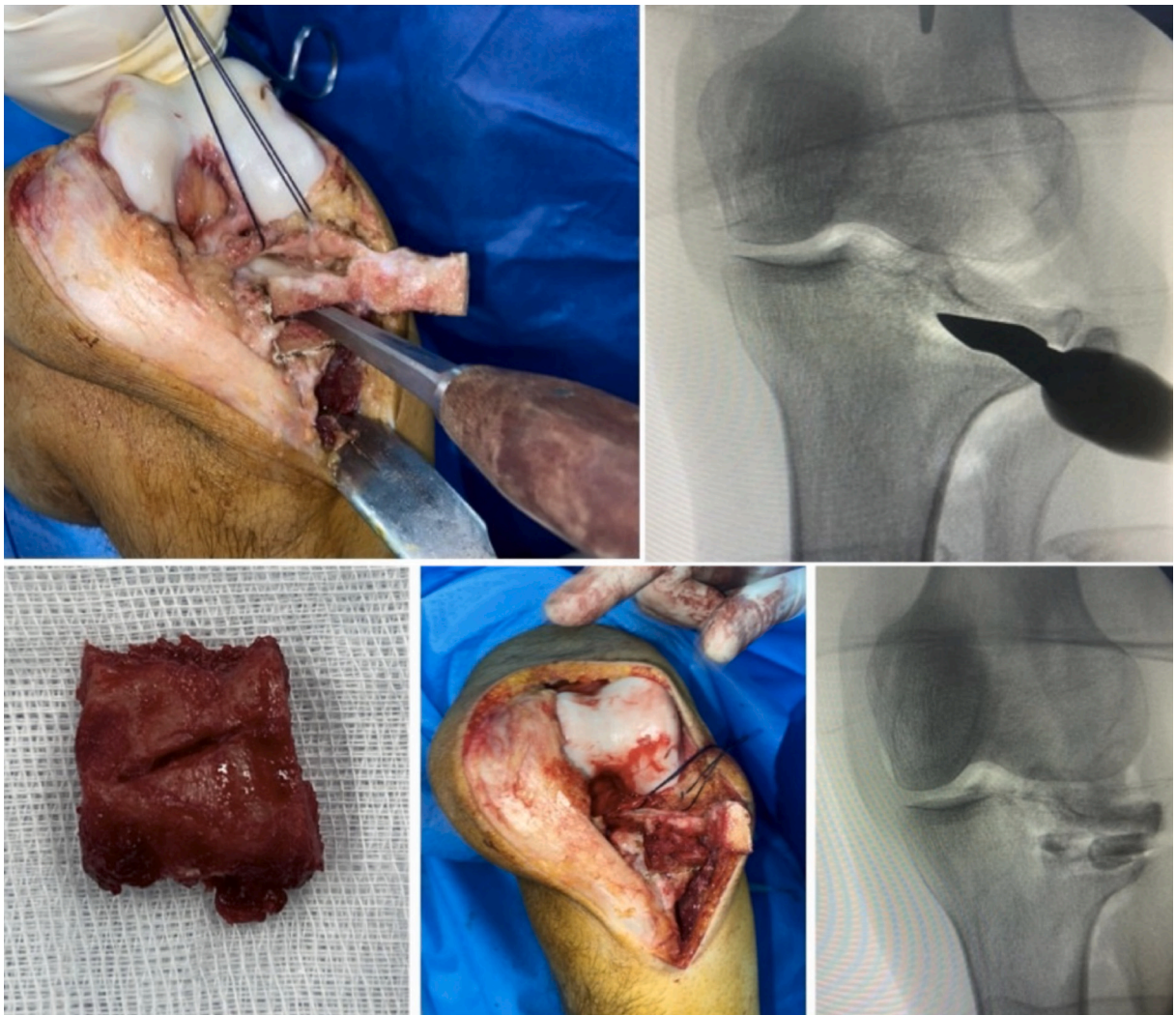


Fig. 7. Open-book osteotomy of the lateral tibial plateau.

Postoperative rehabilitation included immediate controlled passive range of motion exercises. Weight bearing was not allowed for 8 weeks. Partial weight-bearing was then allowed, which gradually progressed to full weight bearing in 12 weeks.

At 6 months after surgery, the patient was pain free, was able to walk without walking aids. The physical examination at that time revealed a pain free knee that was stable with varus and valgus stress, had no angular deformity, and had a normal range of motion. Radiographic Control at 12 Months demonstrated optimal fracture healing, with bone consolidation and Stability of Osteosynthesis Materials (Fig. 10).



**Fig. 8.** Lifting of the joint surface, followed by filling with bone grafting.

## Discussion

Intra-articular malunion are one of the most common late complications of a tibial plateau fracture and affect the femorotibial joint congruence. They are most often the consequence of an initial reduction defect, more rarely of a secondary displacement [8].

Malunion may be intra-, extra-articular or combined, whether secondary to tibial plateau fracture, post-traumatic or secondary to iatrogenic epiphysiodesis or proximal tibial osteotomy. Intra-articular malunion can be classified to [8]:

On the lateral side, they are mainly sequelae of fracture-depression or depression-split with post-traumatic valgus due either to reduction defect or to secondary subsidence and/or tibial plateau necrosis. Secondary subsidence may be moderate (2–3 mm) or more severe (> 4–5 mm). Likewise, split may sometimes exceed 1 cm in neglected or overlooked fracture, especially in case of multiple traumas.

On the medial side, subsidence is exceptional, and usually concerns splitting of the medial condyle involving the tibial eminence (B1). The main fracture line is oblique, upward and outward. Reduction is relatively easy, and medial buttress plate stabilization is straightforward. In case of frontal fracture line with posteromedial fragment detachment, on the other hand, reduction and stabilization are difficult [1]; fixing the fragment is nevertheless essential, to prevent secondary displacement and fixation failure, leading to varus displacement.

The clinical assessment of the patient is essential to determine the therapeutic procedure. In fact, the choice between therapeutic abstention, osteotomy or arthroplasty will be made according to general and local criteria [10]:

General criteria: Age, medical and surgical history, professional and physical activity, history of infection or vascular disease.

Local criteria: Pain, functional impotence, instability, joint range of motion, lower limb deformity, presence of scars.

The radiological assessment is fundamental for the understanding of the intraarticular malunion and to determine the therapeutic

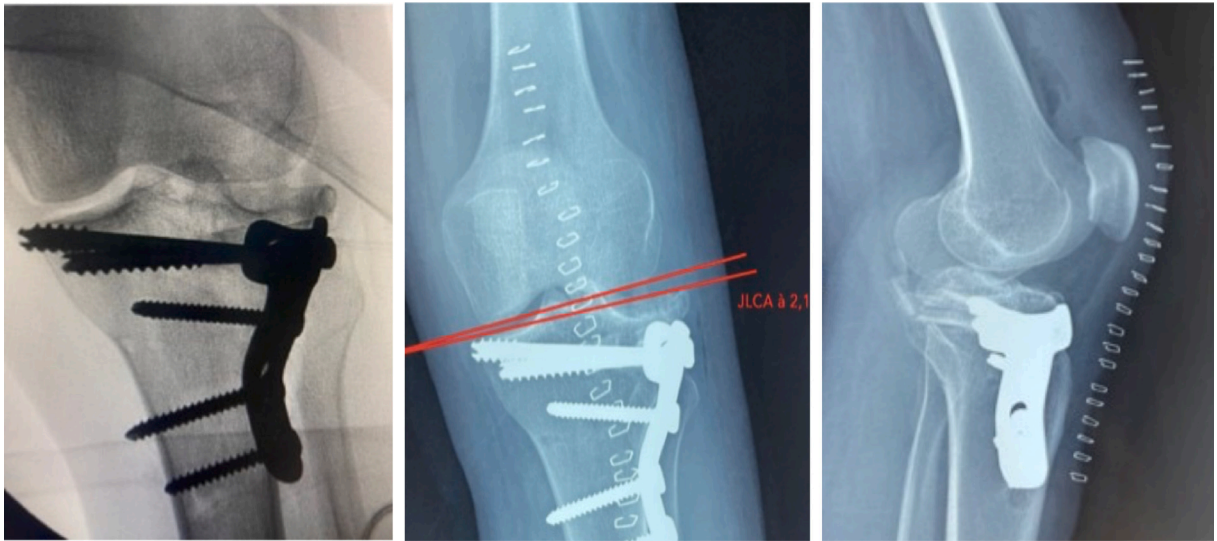


Fig. 9. The post-operative JLCA angle was corrected and measured to 2,1°.

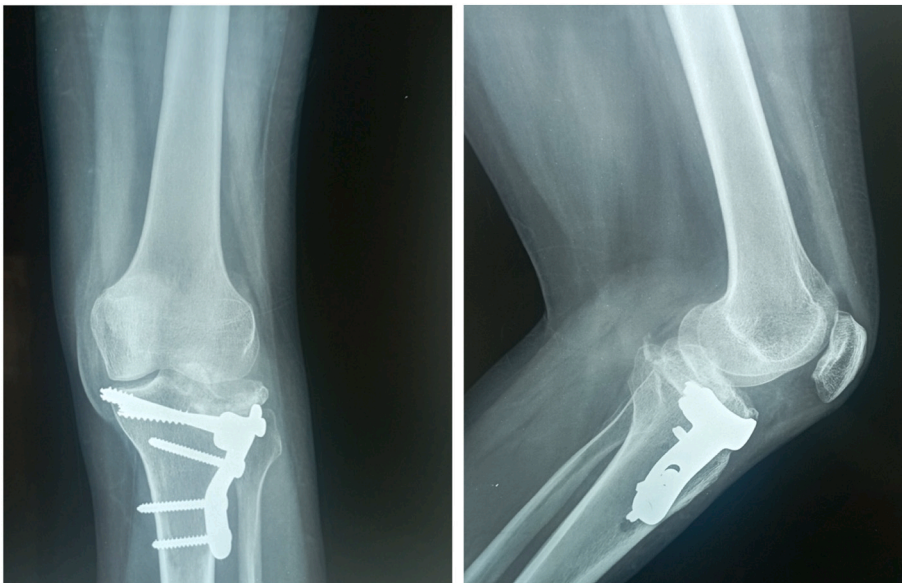


Fig. 10. Radiographic control at 12 months showing bone consolidation and stability of osteosynthesis materials.

choice. It will allow to specify the location of the lesions, to quantify the angular deformation and to control the fracture consolidation. It must include [10]:

**Anteroposterior, lateral, schuss, and stress radiographs:** These allow assessment of the deformity and calculation of the Joint Line Convergence Angle (JLCA), the only parameter measuring intra-articular damage. It is calculated on a front X-ray of the loaded knee. This angle is formed between the tangential lines of the femoral condyles and the tibial plateau. The JLCA has a normal range of 0--2° [11].

**Pangonogram:** This X-ray is essential to measure the Hip-Knee-Ankle (HKA) angle and especially the medial tibial mechanical angle, which allows us to assess the extent of the associated extra-articular malunion.

**A 2D and 3D CT scan:** Will allow analysis of the type of intraarticular malunion (depression, step-fracture), its location (lateral, medial, posterior, etc.) and its importance.

**Magnetic resonance imaging (MRI):** Will allow evaluation of soft tissues (ligament, meniscus) and cartilage lesions.

Surgical options are variable, depending on patient age, sequela severity and patient expectations. A distinction is to be made between conservative (correction osteotomy) and radical surgery (unicompartmental or total knee replacement) [8]:

**Conservative treatment:** Osteotomy is rarely indicated for intra-articular malunion, but should be considered in young and active patients. It is very difficult to set an age limit, but the upper limit might be 50 years. In case of <3 mm lateral depression, extra-articular varization osteotomy, preferably in lateral opening and the opening can be filled by bone substitute or bone graft. In case of depression exceeding 3 mm, extra-articular osteotomy would inevitably lead to an oblique joint-line of  $>5^\circ$ , which is not recommended for the purposes of future joint replacement. In pure central depression, which is the most frequent case, lateral extra-articular condyle elevation osteotomy may be suggested, with fitted bone wedge under the tibial plateau, preferably harvested from the iliac crest, which is the technique that we used for our patient. On the medial side, depression is exceptional, as medial or frontal fracture-split is generally involved, to which we shall return [10]. In case of combined intraarticular and extraarticular malunion, some authors described surgical techniques combining intra-articular and varus opening wedge osteotomy for lateral depression and valgus malunion [12].

**Radical treatment:** Arthroplasty is essentially indicated in intra-articular or combined malunion, where correcting depression is not feasible (Important depression) in patients over 50 years old. It is rarely indicated in pure extra-articular malunion, except in elderly patients with pre-existing osteoarthritis of the knee, whether patellofemoral or tibiofemoral. Depending on the malunion, either a unicompartmental implant may be used, or total knee replacement, with constraint according to surrounding ligament status [13].

Several studies have been published about the outcome of patients with malunion of tibial plateau fractures: Kerkhoffs et al. analysed 23 patients with combined intra and extra articular osteotomy after a mean of 13 years [12]. They showed that a correction of the intraarticular depression and valgus malalignment provides good results. Liangjun et al. analysed 25 patients with malunited tibial plateau fracture while in 15 cases an intraarticular osteotomy was performed and satisfactory patient outcomes were noted. Wang et al. demonstrated 13 patients with posterolateral tibial plateau fracture malunion and intraarticular osteotomy at a mean follow-up of 20 months [14]. The articular step-off was corrected in all patients with satisfactory functional outcome. Lena Alm et al. published a study about 23 patients with intraarticular osteotomy with excellent and good clinical outcome in 73,9 % of the cases and correction of radiological parameters and the lower-limb malalignment with a mean follow-up after 4 years with only two patients converted to a total knee arthroplasty concluding that a reconstructive knee joint preserving technique can delay the necessity of joint replacement [15]. Dimitrios S. Mastrokalos et al. used the same technique of intra-articular Open-Book osteotomy in a case of a tibial plateau fracture malunion with depression with a good clinical and radiological outcome [16].

## Conclusion

The management of post-traumatic intra-articular malunion is a difficult and rare surgery, as it is indicated in young patients. Preoperative planning is essential for understanding the deformity. Intraarticular osteotomy is the only treatment option to prevent a total knee replacement or a long-term impaired patient outcome. Conservative surgery in young, active patients should be preferred, but should not interfere with the possibility of future arthroplasty.

## CRedit authorship contribution statement

**Sohaib E.L. Mahjoubi:** Conceptualization, Writing – original draft, Writing – review & editing. **Ilyesse Haichour:** Conceptualization, Writing – original draft. **Amine E.L. Farhaoui:** Conceptualization, Writing – original draft. **Oussama Jelti:** Conceptualization, Writing – original draft. **Adnane Lachkar:** Conceptualization, Validation. **Najib Abdeljaouad:** Conceptualization, Supervision, Validation, Visualization. **Hicham Yacoubi:** Supervision, Validation, Visualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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