

Allograft for the treatment of traumatic severe bone loss in the lateral femoral condyle: A case report



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ABSTRACT

Background: Open articular fractures are an important issue due to their increasing incidence, along with the rise in motorcycle accidents. Oncology experience with allograft in orthopedics may be extended to cases of traumatic bone loss.

Clinical case: A 37-year-old man with an open fracture of the distal femur and proximal tibia presented a massive bone loss of the lateral femoral condyle after a motorcycle accident. Following Damage Control Surgery, a considerable lateral femoral condyle allograft was used to restore the joint anatomy.

Results: After an intensive rehabilitation program and two subsequent arthroscopic arthrolyses, the patient resumed walking without aids and recovered from stiffness (R.O.M. 0–130°). An MRI performed at median follow-up, revealed a favorable integration of the allograft.

Discussion: Allografts are a reasonable reconstructive option for young individuals with massive bone loss. An appropriately sized allograft is essential to restore an acceptable function as seen in the herein case.

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Introduction

Open fractures and, particularly, severely comminuted articular open fractures are still a surgical challenge.

In road traffic accidents involving pedestrians and motorcyclists, the knee joint is markedly prone to injuries. Knee injuries are reported to cover 14.7% of the total fractures in motorcyclists and open knee fractures are very frequently reported [1]. Despite some uncertainty about the precise prevalence of open injuries due to the changing epidemiology of the different categories of people involved, a broad estimate gives a 58.5% prevalence of open Gustilo III fractures among all fractures in motorcyclists.

High-energy trauma knee fractures may occur in a wide variety of complex patterns and in some cases it is not possible to apply standard treatment protocols. Specific treatments should be aimed at single bone and joint traumatic damage.

Open knee joint fractures with extensive traumatic bone loss rarely occur and are scarcely reported in the literature. Significant articular loss may be treated with massive osteochondral grafts in a more biological attempt to restore the joint [2]. On the other hand, joint replacement, with all its drawbacks, is a further option [3–5]. In

the case of young individuals with a high life expectancy and a high level of activities, it is worth attempting joint reconstruction with massive osteochondral grafts. Conversely, in elder individuals prosthetic joint replacement may become the first surgical option [2].

Clinical case report

On November 10th, 2012, a 37-year-old male was referred (transferred by helicopter) to our emergency department following a road/motorbike traffic accident.

After a first physical examination and imaging assessment the patient was promptly taken to the operating theater because of a severe open fracture-dislocation of the left knee with soft tissue damage and bleeding (Gustilo III A). The patient was hemodynamically stable and without a history of comorbidities or previous surgical procedures (GCS = 15 [6], ISS = 42 [7]). No peripheral vascular or nerve injuries were detectable (Ankle Brachial Index - ABI > 0.9).

Multimodal antibiotic prophylaxis was established with Ceftriaxone 2 g I.V./24 h + Metronidazole 500 mg I.V./8 h until normalization of clinical parameters.

The intraoperative findings were:

- Detachment of the proximal margin of the patella (B1 type following the Speck and Regazzoni classification [8]; 34-A1 type

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following the AO-Trauma classification) determining a full-thickness interruption of the quadricep tendon;

- Fracture of the proximal left tibia: the fracture of the lateral tibial condyle and intercondylar eminence fracture; (41-B3 type following the AO-Trauma classification [9])
- Coronal fracture of the lateral femoral condyle (Hoffa fracture type III [10]) with the missing lateral condyle.

Surgery consisted of damage control intervention for the extremity and initial articular reconstruction:

- Abundant irrigation and extended debridement;
- Reduction of the posterior knee dislocation and assessment of the popliteal vasculo-nervous bundle under direct observation through the traumatic exposure;
- Reduction of the lateral tibial plateau and internal fixation (lag screws) with screws;
- Reconstruction of the extensor retinaculum by means of a tenorrhaphy reinforced with a suture anchor (Corkscrew FT-II Arthrex®) inserted into the proximal portion of the patella;
- Provisional stabilization by bridging using external fixator (Hoffmann II Stryker®), (bi-planar construct with 3 screws in the distal femoral diaphysis and 3 screws in the proximal tibial diaphysis (Fig. 1);

A few days after, an advanced imaging assessment (CT scan) was carried out in order to further assess bone and joint damage (Fig. 2).

On the 21st postoperative day, once wounds had completely healed and the local condition allowed final surgery, the patient was referred to the operating theater for:

- external fixator removal
- tibial plateau fracture open reduction and fixation with LCP plate and screws
- lateral femoral condyle reconstruction with a massive osteochondral allograft fixed with two 4.0 cannulated screws and three 3.0 cannulated Herbert compression screws (Fig. 3).

A few days later, the patient was discharged and referred for a customized rehabilitation program. Partial weight bearing was allowed 2 months later, after X-ray control.

The patient promptly achieved a satisfactory recovery, with the exception of an intra-articular stiffness resistant to any form of rehabilitation. R.O.M. was 10° to 80°.

Therefore, the patient was referred for arthroscopic debridement and arthrolysis (Fig. 4).

After two subsequent arthroscopic arthrolyses (at 5 and 9 months after final surgery, respectively) with extensive debridement of the intra-articular fibrosis, the patient reached satisfactory results with a complete recovery of knee extension and 130° flexion (Fig. 5).

All the available tibial hardware was removed 12 months after final internal fixation because of skin irritation (Fig. 6).

At 2 years' follow-up, an MRI showed the good bone osteointegration of the allograft.

Discussion

Complex multi-fragmentary open fractures involving the knee joint may entail a variety of clinical and surgical challenges. Each fracture may be considered as a unique case and treated specifically. Our case presented with several distinctive characteristics that influenced the treatment and the subsequent satisfactory clinical course. Such features may be deemed so difficult to replicate that our treatment plan may be considered unlikely to be reproduced. From this viewpoint, we agree with such a consideration, but it is worth focusing on the principle/rationale behind some choices and the evidence derived from our experience (Fig. 7).

Firstly, a preliminary observation, the occurrence of a multi-fragmentary tibia fracture with a Hoffa type III fracture of the femur may have played a double-sided / double effect regarding the knee dislocation. Knee dislocation is a consequence of high-energy injury and is characterized by the disruption of the ACL and PCL, as well as the MCL and LCL. The anterior displacement is the most common direction of dislocation, closely followed by the posterior [11]. Complications include ligamentous and meniscal

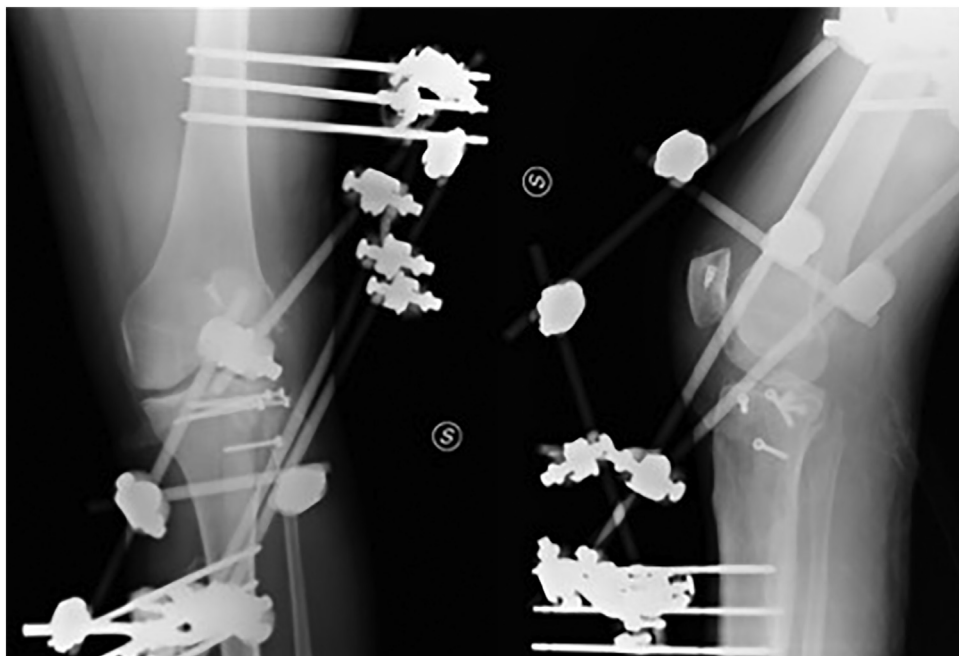


Fig. 1. Standard X-Rays views of the left knee after damage control surgery and initial joint surface reconstruction.

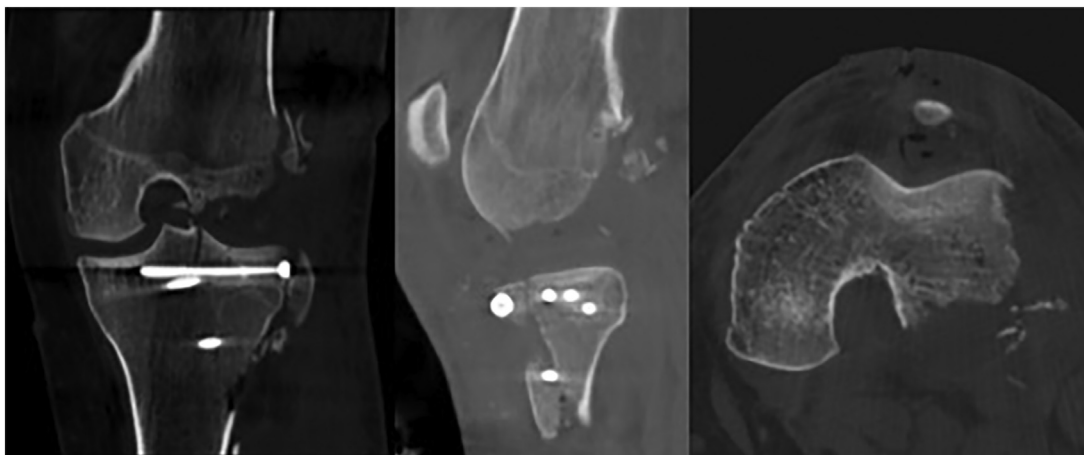


Fig. 2. CT-scan of the knee defining the amount of lateral femoral condyle loss.

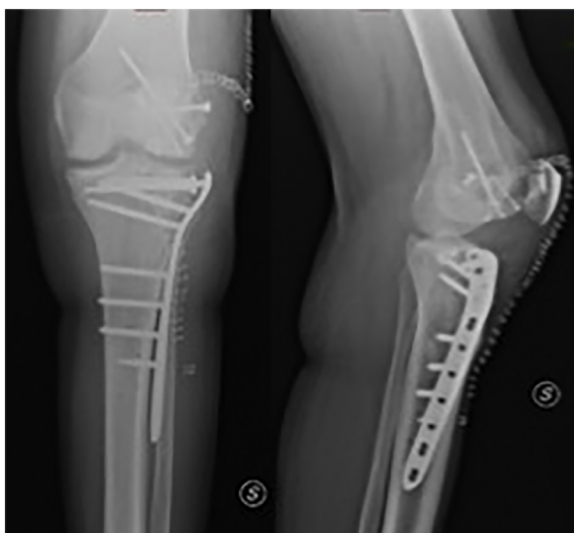


Fig. 3. Post-op standard X-ray control after final synthesis.

injuries, in addition to the popliteal artery, popliteal vein, and nerve palsy. Associated popliteal artery injury accounts for 10–40% of the cases [12]. The incidence of nerve injury is 10–35%, although there is broad variation in the reported series [13,14].



Fig. 4. Maximum knee flexion at April 2013 follow-up.

The simultaneous occurrence/incidence/phenomenon of both femoral and tibial fractures has certainly privileged the dislocation since type III Hoffa fracture line occurs proximally in the insertion of the ACL and LCL [15]. On the other hand, it might have prevented the lesion in the neuro-vascular bundle unlocking the constraints given by the gastrocnemius and the soleus arch [16]. Indeed, it is well known that the popliteal artery is susceptible to injury because of fibrous tethering distal to the soleus arch. Even damage control procedures associated with vascular reconstruction have substantially higher complication rates and the patients may eventually require an above-knee amputation [13,17].

However, the mainstay of the presented case is, in our view, the concurrence of a considerable femoral condyle bone loss with a proximal tibia fracture in young individuals.

Once the damage control procedure has been successful and the patient has recovered from the acute stage, a severe joint derangement required care. Since knee arthrodesis and above knee amputation entailed unacceptable disability, the only reasonable surgical program that could restore functions were either a complex biological reconstruction of the joint or a prosthetic joint replacement.

Occasional total knee replacement (TKR) may be considered after damage control and provisional internal fixation. Early TKR is



Fig. 5. Clinical appearance after the second arthroscopic arthrolysis.

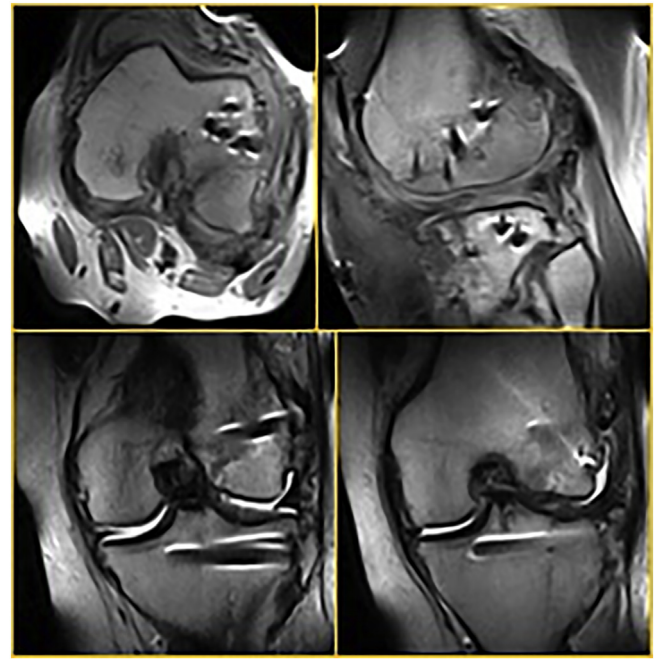


Fig. 7. MRI appearance of allograft after 2 years.



Fig. 6. Standard X-rays after hardware removal.

recommended in patients with pre-existing symptomatic arthritis, patients who are unable to perform restricted weight-bearing, those with extensively comminuted AO type C distal femoral fractures or those in whom a secondary procedure is best avoided [3].

TKR after a post-traumatic case with some residual hardware is challenging. Functional outcomes are modest and complication rates high [18,19]. Treatment with TKR of an initial fracture is not consistent with the outcome of primary TKR without complications [20,21]. Moreover, due to the considerable bone loss and complex ligamentous instability, there was a strong indication towards a forced revision TKR whose short-term and, above all, long-term results dissuade using the procedure among young individuals.

Our choice of reconstructing the joint by means of massive allograft goes back to previous experience of wide resection after distal femoral tumors. Normal anatomy in oncology is often restored using bone bank allograft [22]. Osseo-articular allografts

for biologic reconstruction of skeletal defects may imply noticeable drawbacks. Complications related to biomechanical insufficiency and biological adverse immunological responses may occur [22].

Their best indications include complex reconstruction procedures, such as post-traumatic deformity and bony loss associated with intra-articular fractures, most commonly of the tibial plateau [23,24].

Intact articular cartilage is a fairly privileged tissue, as it is not vascularized and its cellular portion is embedded in the extra cellular matrix, inaccessible to the host immune system. The bone tissue, on the other hand, is loaded with potentially immunogenic cells and proteins. It is well known that the bone portion of the graft is eventually replaced by host bone, the process of creeping substitution, which may lead to osseointegration and complete replacement of allograft bone by host bone [25,26].

In our case, we obtained good clinical results with acceptable functional recovery up to our 5 years' follow-up. Even if a deterioration of the clinical outcome may occur and post-traumatic arthritis is foreseeable, the favourable integration of our allograft has given our patient the chance to eventually turn to an unconstrained primary prosthetic implant whenever necessary.

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