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Saudi Orthopedic Association

Journal of Musculoskeletal Surgery and Research

Case Report

Femoral fracture fixation followed by ipsilateral amputation: A case report

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Received: 18 December 2022
Accepted: 06 March 2023
EPub Ahead of Print: 18 March 2023
Published: 06 May 2023

DOI
10.25259/JMSR_156_2022

Quick Response Code:

ABSTRACT

Severe crushing injury of the lower limb presenting as a concomitant femoral subtrochanteric fracture, ipsilateral open knee dislocation, and associated popliteal artery injury is unusual. Due to poor general and local conditions, despite a vascular repair, we performed a femoral fracture fixation followed by transfemoral amputation of the lower limb. The report aimed to demonstrate the effectiveness of this definitive treatment as one of the options in these difficult cases. The knee dislocation reduction was performed in the emergency operating room and the lower limb was stabilized with an external fixator. Vascular surgeons performed revascularization of the extremity with a femoropopliteal vascular bypass. Leg fasciotomies were performed and broad-spectrum antibiotics were administered. Several attempts at fasciotomy revisions and necrotic tissue debridement were made by plastic surgeons. Ten days after hospitalization, concomitant local rhabdomyolysis and deep soft-tissue infection lead to life-threatening sepsis. An above-the-knee amputation was quickly required. We performed an emergency proximal nailing of the femoral fracture and, subsequently, a transfemoral amputation at the distal third. In this case, we described the successful use of intramedullary nailing as a good option for stabilizing acute subtrochanteric fracture of a limb that required an above-the-knee amputation. This strategy saved the patient's life, and intramedullary fixation with a short nail provided reliable bone stability for rapid and better functional recovery.

Keywords: Femoral fracture, Lower limb amputation, Open injury, Knee dislocation, Popliteal artery injury

INTRODUCTION

Few cases of concomitant long bone fracture fixation and ipsilateral amputation are reported in the literature, and most of them were reported in war scenarios.[1-4] These reports described fractures of the long bone proximal to "*traumatic amputations*." In these cases, the site is often contaminated. Debridement and irrigation of the open lesions are necessary and immediate definitive fixation of the proximal fracture is precluded. External fixation is usually applied and only internal fixation is subsequently performed. Nowadays, there are still few tools that can help surgeons manage these uncommon injuries in the civil environment. No fixation technique has been shown to be superior to the others, and the standard procedures cannot be applied.[1-3] We present a case of a severe crushing injury of the right lower limb with a femoral fracture, ipsilateral open knee dislocation, and associated vascular injury. This kind of trauma is very rare and requires a multidisciplinary approach. Due to poor general and local conditions, we performed a femoral fracture fixation followed by transfemoral amputation of the lower limb

How to cite this article: Cerbasi S, Orabona G, Dulla D, Pascarella R. Femoral fracture fixation followed by ipsilateral amputation: A case report. J Musculoskelet Surg Res, 2023;7:128-34.

to avoid additional surgeries and quickly achieve maximum function and mobility. When a young adult in good general condition requires a lower limb amputation, it is best to immediately provide a limb prosthesis for the patient to achieve early function and mobility.[5] The decision to proceed with definitive treatment can be challenging. We illustrated our strategy and experience in this report.

CASE REPORT

A 30-year-old man presented to our hospital with a severe crushing injury of the right limb. The patient was involved in a work-related trauma. A large and heavy moving object hit him. The primary examination showed a proximal femoral fracture, a knee dislocation with an open popliteal wound and an ischemic limb [Figure 1]. Angio-CT scan showed a vascular injury of the popliteal artery. In the emergency operating room, we reduced the knee dislocation. We temporarily stabilized the lower limb with an external fixator to allow the vascular surgeons to perform a femoropopliteal bypass [Figure 2]. Leg fasciotomies were made and broad-spectrum antibiotics were administered. The time between injury and surgery was about 5 h.

Afterward, the patient was hospitalized in the intensive care unit. The day after, the color Doppler ultrasound examination documented good limb perfusion. A routine post-operatory angiography examination showed bleeding of a terminal branch of the deep femoral vein that was urgently embolized. A high value of myoglobin (19.000 ng/mL) was reported. Three days after hospitalization, the patient became febrile. On the 4th day, we expanded the fasciotomies. On the 5th day, *Klebsiella aerogenes* was detected in bronchoalveolar lavage. The patient developed several fistulas on the foot and the thigh. Plastic surgeons made another surgical revision of fasciotomies and debridement of necrotic tissue. Blood cultures revealed a *Staphylococcus aureus* infection.

On the 7th day, the skin of the extremity became marbled, even though another color doppler examination confirmed peripheral perfusion. Plastic surgeons suggested deep tissue necrosis with superinfection on fasciotomy sites, so on the 8th day, they made a surgical revision and took biopsies [Figure 3]. Two days later, the patient became febrile again and unresponsive to antibiotics and antipyretic medications. Tissues showed the presence of rapidly ascending necrosis and purulence. The patient developed multiple organ dysfunction syndrome due to septic status. He was tachypneic, hypocapnic, and hypoxemic; he developed moderate liver dysfunction and renal shutdown due to myoglobin nephrosis and hyperkalemia. Blood tests showed leukocytosis, high C-reactive protein, and procalcitonin level. After a multidisciplinary re-evaluation (between vascular, plastic, and orthopedic surgeons), it was decided to conduct a transfemoral amputation [Figure 4].

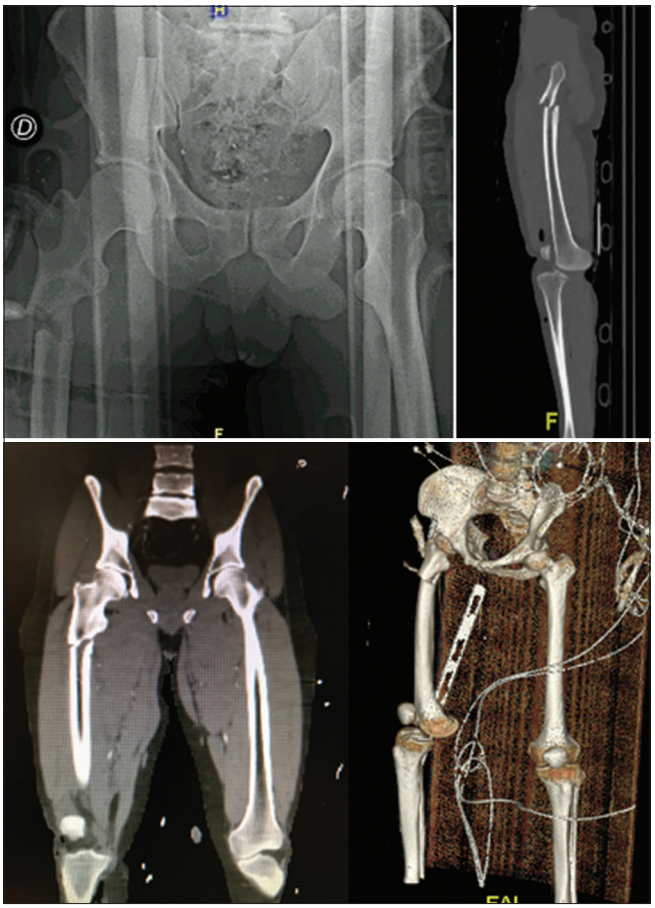

Figure 1: Radiographs and computed tomography-scan showing subtrochanteric fracture and ipsilateral knee dislocation of the right femur.

Figure 2: Radiographs showing reduction of the knee dislocation and stabilization lower limb with external fixation. Successively, vascular surgeons performed revascularization of the extremity with a femoral-popliteal vascular bypass and leg fasciotomies were praticated.

A real challenge was to fix the femoral fracture in the same setting. Certainly, amputating and leaving the external fixator in place was safer and more convenient, but we chose to perform total care.

We have synthesized a fracture away from the site of infection and the amputation has eliminated the contaminated zone

Figure 3: Clinical images demonstrating tissue suffering. Several attempts of fasciotomies revisions and necrotic tissue debridement were conducted by plastic surgeons.

Figure 4: Pre-operative clinical images. Tissues showed presence of rapidly ascending necrosis and purulence. The patient developed deep soft-tissue infection and life-threatening sepsis.

of injury. In addition, the amputation was performed at the most distal viable level of the extremity to preserve as much limb length as possible in healthy soft tissues. We also

Figure 5: Immediately post-operative. We performed a femoral subthrocanteric fracture fixation followed by transfemoral amputation of the lower limb in the same procedure.

believed that intramedullary fixation of the femur fracture on the amputated thigh would be challenging. Hence, during our procedure, we decided to remove the external fixator. We reduced and stabilized the fracture with a standard 180 mm, 125° Gamma 3 locking nail system (Stryker®). With the patient in the supine position, the right limb was placed in traction, subtrochanteric proximal closed fracture reduction was performed under an image intensifier control, and antegrade nailing insertion was achieved following the standard surgery technique. The nail was advanced by hand, and we achieved static locking of the nail. Finally, we performed an ipsilateral transfemoral amputation at a lower level, thus preserving the maximum needed length of the residual limb [Figure 5]. The next day, after continuing antibiotic therapy, the general condition improved. Laboratory tests in the following days showed a gradual decrease in leukocytes, C-reactive protein, and procalcitonin levels. Liver markers, myoglobin, and creatine phosphokinase were also declining. *Acinetobacter baumannii* was identified in the central venous catheter and fasciotomy biopsy samples were taken before amputation. *Stenotrophomonas maltophilia* was cultured from the surgical wound swab. No surgical revision on the amputation stump was needed. On the 21st day of hospitalization, the patient was transferred to the infectious disease department to resolve the septic state.

The patient was followed clinically and radiographically at 4 weeks, 3 months, 6 months, and 1 year. The patient started functional rehabilitation with weight-bearing 2 months after the injury. He got a custom-made prosthesis. At the same time, the radiographic union of the subtrochanteric fracture was observed after 3 months. Six months after our procedure, the patient resumed his daily life activities with a few limitations.

The patient was evaluated at the final follow-up with the locomotor capability index (LCI),[6] a functional questionnaire of the amputee. The LCI is a self-administered disease-specific validated outcome score for assessing locomotor abilities generally considered essential for patients receiving prostheses' basic and advanced activities of daily living. It comprises 14 questions about different locomotor activities while wearing the prosthesis, with a possible maximum score of 56 points. Higher scores are associated with better function and less dependence on assistance. The subject obtained 51 points.

Another index used to evaluate the final outcome was the Quebec user evaluation of satisfaction with assistive technology (QUEST) questionnaire,[7] a score that measures how satisfied you are with your devices and the related services you experienced. The QUEST is divided into 12 satisfaction items. The user answers each question with a score ranging from 1 (not satisfied at all) to 5 (very satisfied). He scored an average of 4.1 out of 5 points.

DISCUSSION

The 30-year-old man presented to our department with four different injuries: A femoral fracture, a complete knee dislocation, a vascular injury, and a crush injury. A multidisciplinary approach was required. Traumatic knee dislocation is a rare injury. Its prevalence is 0.02% of orthopedic injuries.[8-12] These injuries are complex and often misunderstood. The most common mechanism of traumatic knee dislocation is high-energy trauma, which usually happens in motor vehicle collisions (50% of reported knee dislocations).[13,14] In 12% of knee dislocations, a surgical amputation is needed in case of complications.[15] Complications in knee dislocations include compartment syndrome, deep vein thrombosis, and, most commonly, neurologic and vascular injuries. Knee dislocation is often a medical emergency requiring prompt evaluation with appropriate imaging. An angio-CT scan was mandatory. In our case, the direct consequence of knee dislocation was a popliteal artery injury.

According to Keeley *et al.*,[16] there is no difference in the incidence of amputation between the patients who underwent orthopedic fixation before vascular repair and those who underwent vascular repair first. The author reported that up to 19.6% of popliteal injuries need secondary limb amputation. In this case, both the vascular injury and the knee dislocation were managed initially. The main goal in this young man was to save the injured limb. We believed that the patient could benefit from salvage surgery by revascularization and obtaining a functional limb. Early revascularization, within 6 h of injury, can prevent tissue ischemia. In our case, the time between injury and surgery was about 5 h.

Nevertheless, a soft-tissue infection began to develop, both due to direct crush injury and inadequate vascularization, which brought the patient to a life-threatening emergency situation. Although our institution is a level 2 trauma center, we never observed such a complex surgical treatment in an emergency situation. Even today, we could not identify any reports in the literature describing the treatment of proximal femoral fractures in young adults subsequently amputated above the knee at the same surgical time. Few works conducted on soldiers in war scenarios can be comparable with our report.[1-4] In 2007, Pickard-Gabriel *et al.* showed the results of two patients treated with femoral fixation in acute transfemoral amputation.[1] In both cases, temporary fixation was performed first; subsequently, internal fixation was made with intramedullary rods, and heterotopic ossification was surgically excised in a third case. Wagner *et al.* described a technique of retrograde intramedullary fixation of fractures through open traumatic amputations and presented good clinical outcomes in ten patients.[3] After amputation, the fractures were initially stabilized with provisional unilateral external fixation and then treated with retrograde intramedullary nailing through the zone of amputation just before the final amputation revision.

Gordon *et al.* demonstrated that acceptable results could be achieved with definitive fixation of a fracture of the long bone proximal to a traumatic amputation, even though with high complication rates.[2] He reported that 89% of the cases developed an infection requiring surgical debridement during their treatment course, and 76% of the patients developed heterotopic ossification, with operative excision required in 39% of this population. Indeed, heterotopic ossification is a well-documented complication of high-energy bone and soft-tissue trauma.[17]

In our experience, we performed a femoral fracture fixation followed by transfemoral amputation of the lower limb at a more distal site in the same procedure. The treatment was definitive and avoided further surgeries, possibly determining a lower rate of complications and a shorter hospitalization time.

When traumatic lower limb amputation occurs in a healthy young adult, obtaining a functional lower limb prosthesis is the best outcome.[5] In addition, Doukas *et al.* stated that amputee patients might receive more targeted rehabilitation in the early stages of recovery than people with limb salvage,

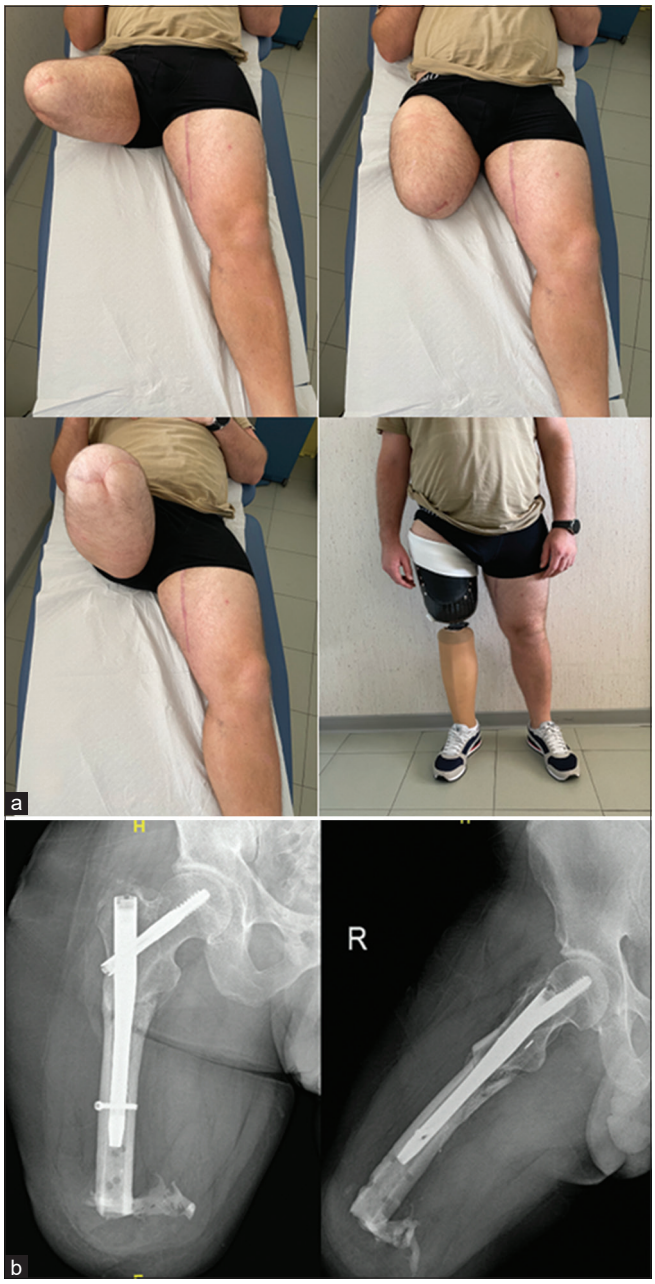

Figure 6: (a) Satisfactory clinical outcome at 1-year follow-up (a). Intramedullary fixation with a short nail provides reliable bone stability for immediate weight-bearing on amputated limb and rapid functional recovery. (b) Radiographs (b) showing the union fractures with some intramuscular heterotopic ossification.

who may have to wait 3 months or more before they can fully bear weight (to allow time for fractures and bone defects to heal).[18] Our follow-up showed that after just 2 months, the patient started rehabilitation and restored his daily life activities with minimal functional limitations 6 months later. We used two validated scores to assess our patient's overall function and satisfaction during his rehabilitation. The functional outcome and radiological recovery after a 1-year follow-up were extremely good [Figure 6].

The functional recovery is directly correlated to the residual length of the stump. Several authors established that the more distal the level of amputation, the better the result in terms of overall function and efficiency in the ability to walk.[5,16,19-24] However, there is a limit: A position too close to the knee may require revision because the knee level in the prostheses will not be functional. We attempted to keep the residual stump at the level determined by the viability of the soft-tissue envelope to maximize the residual limb's length.

Furthermore, Perkins *et al.* affirmed that the decision between limb salvage and amputation is a complex issue and a delayed or incorrect decision could lead to worse outcomes.[25] Subsequently, Perkins *et al.* attempted to identify the prognostic factors for amputation following a surgical vascular repair in a meta-analysis study.[26] As a result, the mechanism of injury, site of arterial injury, multiple levels of arterial injury, associated fractures, major soft-tissue injury, duration of ischemia exceeding 6 h, compartment syndrome, and surgical method of vascular repair were identified as outcome predictors for amputation. The authors further stated that, as in our specific case report, the damage of the limb tissue might be a direct consequence of both the energy transferred during the injury and the effects of the ischemic necrosis and the level and extent of tissue damage are directly related to the outcome.

Recently, Ali *et al.* reported that patients who suffered from prolonged ischemia (>6 h) had a 4 times higher risk of secondary amputation.[27] The most common reason for failed revascularization was arterial thrombosis and infection (around 66% of their study population).

Very few tools help manage these complex cases when they come to emergency rooms, and they are not always available. In 1990, Johansen *et al.* proposed the mangled extremity severity score (MESS), a scoring system predicting limb salvage that constituted four levels with different scores.[28] Its simplicity, accuracy and foundation on objective criteria still determine the usefulness of this tool today. Our case's retrospective MESS score was 7, indicating a need for immediate amputation.

However, we can accept that earlier reduction and fixation may be a reasonable treatment option in cases of acute femoral fracture and incipient transfemoral amputation. To the best of our knowledge, no authors previously described this procedure.

It is necessary to remember that the trauma team's unexpected and sometimes, miraculous success in saving mutilated limbs has occasionally misled into attempting salvage for virtually any severely damaged extremity.[28]

CONCLUSION

Intramedullary fixation of the femoral fracture with a short nail provides reliable bone stability for immediate weight-bearing on an amputated limb and rapid functional recovery.

AUTHORS' CONTRIBUTIONS

SC: Conceptualization; Data curation; Supervision; Writing – review, and editing. GO: Writing – original draft. DD: Investigation. RP: Validation. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient-informed consent. The patient has given consent for his images and other clinical information to be reported in the journal. The patient understands that his name and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

FINANCIAL SUPPORT AND SPONSORSHIP

This study did not receive any specific grant from public, commercial, or not-for-profit funding agencies.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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