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Case Report

# Bifocal Bone Transport over a Preexisting Nail to Treat a Septic Femoral Shaft Nonunion

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**Keywords**
Bifocal bone transport · Intramedullary nail · Septic nonunion · Ilizarov

**Abstract**
Intramedullary nailing is the method of choice for the treatment of most femoral shaft fractures. However, it is not always an easy procedure with predictable results as leg length discrepancy as well as rotational and angular malunion may occur. Lengthening over an intramedullary nail (IMN) has become very common as it allows early removal of the external fixator. This report presents a case of an open femoral shaft fracture initially treated with an IMN and subsequently complicated by a septic nonunion. Union was obtained by bifocal bone transport with a circular external fixator over the preexisting nail without exchange or removal of the previously inserted IMN. In conclusion, the presence of an IMN supports osteotomy and regenerates bone during bone healing, prevents fracture and/or deformation of the regenerated bone, and reduces the time needed for the external fixator.



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## Introduction

Intramedullary nailing is the gold standard treatment of the majority of femoral shaft fractures, with a low complications rate [1]. The incidence of infection following closed long bone fracture is 1–2%, while the risk of infection following intramedullary nailing has been reported to be 4–7% and increases in case of an open fracture [2–4]. In open fracture, time from trauma to surgery, longer surgical duration, failure to assume postsurgery antibiotic therapy, missing the follow-up, and immunodeficiency are important factors that increase the risk of infection. Septic nonunion remains a big challenge for all orthopedic surgeons [3]. Antibiotic-impregnated cement nails, vascularized bone grafts, autogenous bone grafts, distraction osteogenesis bone marrow aspiration, demineralized bone matrix, and platelet concentrates are used for the treatment of septic nonunion after fractures [5]. However, early debridement associated with oral or intravenous antibiotics, until bone union, followed by nail removal and reaming of the femoral canal seems to be the most effective treatment in early postoperative infections [6].

The aim of this case report is to present the bifocal bone transport over an preexisting nail for the treatment of septic nonunion of the femoral shaft.

## Case Presentation

We present the case of a 33-year-old Caucasian man with a background history of open comminuted fracture of the left femur (type IIIA according to the Gustilo classification) [7]. The patient had a working incident 3 years ago and was initially treated in another hospital. According to the medical records and patient story, the open comminuted fracture of the left femur was initially treated with an external fixator changed to intramedullary nail (IMN) 10 days after trauma. Nail dynamization was performed 10 weeks later. One year after trauma, pseudoarthrosis occurred and debridement of the fibrous tissue with iliac bone graft was performed. The nail was removed 2 years after trauma, but due to a hypertrophic nonunion, a new larger-diameter nail was placed after intramedullary reaming, dynamized 4 months later (Fig. 1).

The patient presented to our outpatient clinic with a previous diagnosis of methicillin-resistant *Staphylococcus aureus* infection of the left femur resistant to all antibiotics. Preexisting infection was confirmed by antibiograms performed at the previous hospital. From the previous medical records the patient had stopped all antibiotic therapy 2 months before our surgery. All inflammatory indices were normalized (erythrocyte sedimentation rate, C-reactive protein, white blood cells count). No skin redness or lesion or fistulae were present. The patient presented with pain and weakness of the left lower limb during walking with a positive Trendelenburg sign on the left side. There was tenderness at the fracture site. Hip range of motion was normal, while knee range of motion was 0–110. No axis deviation or leg length discrepancy was present clinically or radiographically.

Preoperative planning was performed using radiograms and MRI images, which confirmed the hypertrophic nonunion at the previous fracture site. No radiographic signs of bone lesion were observed around the screws of the preexisting IMN.

Resection of the infected bone segment (5 cm), soft tissue debridement, and stabilization using a circular external fixator according to Ilizarov's principles were performed. K wires and half pins were used to avoid contact and friction with the existing IMN. Osteotomy was performed just proximally to the distal locking screws of the IMN to allow bone transport from

distal to proximal. A Gigli saw was used for the posterior, medial, and lateral parts, while anteriorly osteotomy was performed using an osteotome. All osteotomies were performed carefully to protect the shaft of the nail.

Bone transport started gradually 12 days after surgery. Daily 0.5 mm of bony distraction was performed distally, while proximally 0.5 mm of compression was applied at the resection site. The absence of skin lesion, fistulae, and pathological collections as well as the normality of inflammatory indices allowed us to maintain the IMN in situ (Fig. 2). Antibiotic prophylaxis with 2 g of cefazoline as intravenous infusion was performed before surgery as suggested by colleagues specialized in infectious diseases. The resected bone and soft tissue samples were sent to the microbiology laboratory. The presence of methicillin-resistant *S. aureus* was not confirmed at the resected bone or soft tissue samples at the time of operation, so no further intravenous or oral antibiotic therapy was performed.

Within 3 months, the infection was eradicated and bone transport was concluded with the bone surfaces almost in contact one to each other. Then, a new debridement of the bone surfaces with autologous iliac bone grafting, locking of the nail, and removal of the external fixator were performed (Fig. 3). Radiograms were performed monthly until complete bone healing (3 months after surgery).

At 24-month follow-up the patient had full weight bearing without any clinical or radiographic leg length discrepancy, axis deviation, or malrotation, satisfactory knee range of motion, and normal infection indices (Fig. 4, 5).

## Discussion and Conclusion

The goal of treatment for femoral infection after fracture when an IMN has been placed is to eradicate infection, obtain bone healing, and improve the patient's functional results. Treatment includes debridement, fracture stabilization, soft tissue reconstruction, and assumption of systemic and/or local antibiotic. Stable fixation is essential to obtain complete bone union, but as long as the IMN is in place, eradication of infection by systematic antibiotic therapy is difficult [8, 9].

Removal or retention of the IMN in case of infection is still controversial. Several authors have suggested to retain the IMN in case of acute infection and then remove it, and to perform a new reaming and debridement after fracture healing [10]. In our study, an external fixator was placed over the preexisting IMN using the principles of lengthening over an IMN [11–14]. According to the principles of the Ilizarov technique, circular external fixation permits to fill up bone defects by corticotomy and bone transport after debridement [15, 16].

The presence of an IMN supports osteotomy and regenerates bone during bone healing, prevents fracture and/or deformation of the regenerated bone, and reduces the time needed for the external fixator. The preexisting IMN was finally "reused" after frame removal without any need to change the IMN, avoiding further surgery and further soft tissue damage. Finally, the preexisting IMN permitted to remove the external fixator earlier, making treatment faster and more comfortable for the patient.

This technique should be avoided in case of chronic active infection (e.g., discharging sinus and elevated inflammatory indices). In these patients nail removal is mandatory, followed by accurate debridement, overreaming of the medullary canal, and adequate irrigation before Ilizarov frame application.

The authors suggest that the present highly specialized technique should be attempted only by experienced Ilizarov surgeons.

## Statement of Ethics

Informed consent was obtained authorizing treatment, radiological examination, photographic documentation, and publication of data.

## Disclosure Statement

The authors of this article have no conflicts of interest to declare. No funds were directly or indirectly received in support of this study.

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**Fig. 1.** Radiographic outcome of the initial femoral open comminuted fracture, obtained on June 2015 when the patient presented to the outpatient clinic. Hypertrophic nonunion, previously treated by preexisting IMN removal, intramedullary reaming, and placement of a longer IMN, is highlighted. IMN, intramedullary nail.

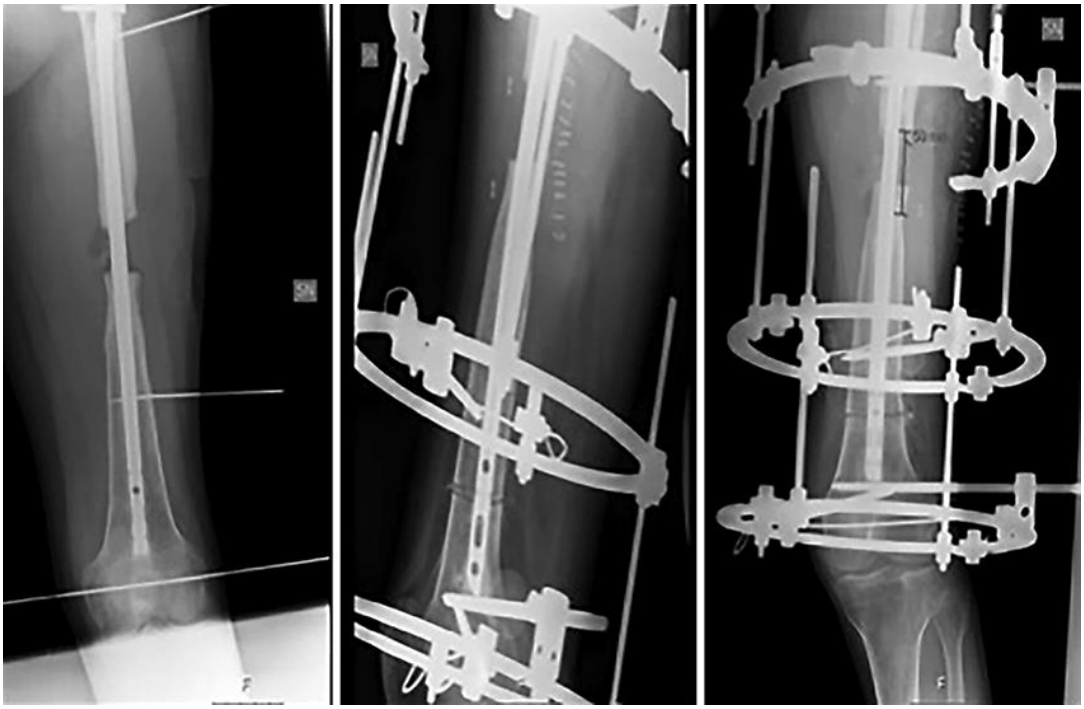

**Fig. 2.** Radiograms obtained after resection of the infected bone segment and stabilization using a circular external fixator, according to Ilizarov's principles, maintaining the preexisting IMN in situ. IMN, intramedullary nail.

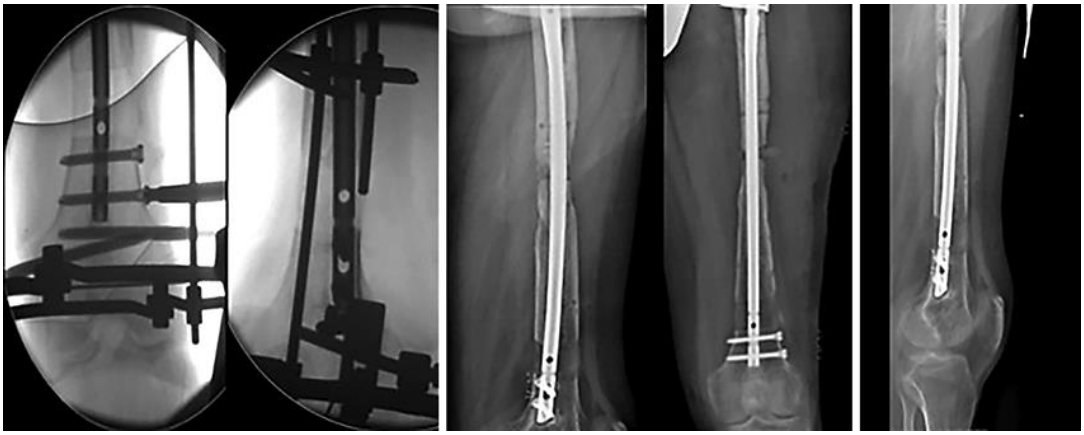

**Fig. 3.** Radiograms 3 months after surgery. Infection was eradicated and bone transport was concluded. The nail was locked, a new debridement was performed with application of iliac bone graft, and the external fixator was removed.

**Fig. 4.** At 24-month follow-up the patient had full weight bearing without any clinical leg length discrepancy, axis deviation, or malrotation, and satisfactory knee range of motion and a normal infection index.

**Fig. 5.** Clinical aspect of the treated left lower limb at 24 months. No leg length discrepancy, axis deviation, or malrotation was observed with a satisfactory range of motion of the knee.