# Distraction osteogenesis in femoral infected nonunion
## Case report

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**Abstract**

We report a case of femoral infected non-union secondary to open fracture type III C, treated with distraction osteogenesis. Thirty-two-year old male who undergoes open fracture in his right femur associated with arterial injury due to gunshot. He is subject to emergency surgery and given surgical toilet, external fixation and arterial repair. He develops distal femoral infected non-union, so, 24 months after the injury he is subject to ample resection with a 12-cm bone defect remaining which is solved by distraction osteogenesis. Distraction osteogenesis is useful for repair and healing of diverse bone defects. It takes a patient committed to a demanding therapeutic process.

**Key words:** Distraction osteogenesis; bone transport; bone lenghtening.
**Level of evidence:** IV

**Osteogénesis por distracción en seudoartrosis infectada de fémur. Caso clínico**

**Resumen**

Comunicamos un caso de seudoartrosis infectada de fémur secundaria a una fractura expuesta de tipo IIIC, tratada con osteogénesis por distracción.

Hombre de 32 años con una fractura expuesta de fémur derecho con lesión arterial por disparo de escopeta. Es operado de urgencia y se le efectúa limpieza quirúrgica, fijación externa y reparación arterial. Evoluciona con una seudoartrosis infectada femoral distal, por lo que, a los 24 meses de evolución, es sometido a una resección amplia y queda un defecto óseo de 12 cm, que se resuelve mediante distracción osteogénica.

La osteogénesis por distracción es útil para obtener la reparación y la consolidación de variados defectos óseos. Requiere de un paciente comprometido con un proceso terapéutico demandante.

**Palabras clave:** Osteogénesis por distracción; transporte óseo; alargamiento óseo.
**Nivel de Evidencia:** IV

Conflict of interests: The authors have reported none.

## Introduction

The bone is a hard tissue extremely versatile, which can regenerate itself forming tissue that is exactly the same as the original. However, its osteoformative ability is limited and, in order to repair larger bone defects, it is necessary to resort to bone substitutes such as bone graft coming from the individual him or herself or from another person,[1] or such as osteoconductive biomaterials.[2,3]

Cancellous autograft is still the best bone substitute; however, it is associated with acknowledged restrictions such as the low amounts of available bone tissue and potential morbidity in the donor site.[4] On the other hand, bone allograft either frozen, cryopreserved or lyophilized requires a tissue bank and an appropriate number of donors, and its use implies the risk of disease transmission for the receptor.[5]

Bone graft limitations have allowed medical doctors to use varied biomaterials that have proved to be useful as bone substitutes; among them, diverse calcium phosphate-based ceramics stand out, because they have acknowledged osteoconductive properties and they are able to give the bone a scaffold which is timely substituted by newly formed bone tissue. However, the use of biomaterials is still limited to the repair of epiphyseal and metephyseal bone defects.[2,3]

Taking into account bone substitutes restrictions, we have thought about the importance of corroborating the absolute validity of distraction osteogenesis—acknowledged, studied and validated by Ilizarov after Second World War by establishing the biological principles that characterize this innovative reparative procedure that allows us to solve successfully varied bone defects, even diaphyseal defects.[6,7]

Distraction osteogenesis is the bone neoformation process which occurs after bone cortical osteotomy, periosteal preservation with periosteal bone-formative cells, and gradual separation of two or more skeletal segments by distraction devices, either longitudinal or transversally, until regenerating complex bone tissue defects by minimally invasive methods.[8]

Our aim is to report a case of femoral infected nonunion secondary to open fracture with arterial injury, which confirms the validity of distraction osteogenesis as a reparative method for complex bone injuries.

## Case

Thirty-two-year old male who gets gunshot by pellet-gun and suffers open fracture type IIIC in the distal third or his right femur with injury of femoral artery and vein, which require immediate repair. He is admitted at the ER at a General Hospital, where he is subject to surgery with surgical toilet, closed reduction, external fixation and arterial and venous bypass with autologus vena safena magna.

The patient does postoperatively well, vascular repair works properly, and external fixation stabilizes adequately the femoral fracture. One month later, the external fixator is removed and the patient receives AO conventional locking IM nailing. Outcomes are not good, however, and 8 months later, there is still a solution of continuity at the level of the fracture, without radiologic signs of bone healing.

By postoperative month 12 there are several fistulas with purulent drainage in the right thigh, whose bacterial culture reveals multiresistant *Staphylococcus aureus. Therefore, antibiotic therapy starts, the IM nail is removed and an external fixator is re-inserted with consecutive surgical toilets at the level of the fracture. However, 24 months later, the infection remains, the external fixator has had to be re-positioned thrice and an infected non-union in the distal third of the right femur is established (Figure 1).*

The patient is referred to our Center two years after the injury with an external fixator which stabilizes poorly the injury and with multiple pellets in the surrounding soft tissues. The case is evaluated at round meetings and the decision we make is to operate the patient on to carry out ample removal of the infected non-union area, to remove a 12-cm bone segment, to carry out cortical osteotomy in the sub-trochanteric area and to insert a monolateral external transporting fixator. Two weeks later we start bone transport in the diaphyseal femur segment at a1 mm/day rate during 4 months with no additional complications (Figure 2).

The process of progressive lengthening allows us to get 12- cm distraction; later on, the transported segment makes contact with the distal femoral metaphysis, and the monolateral transporting fixator is neutralized and later removed (Figure 3). Afterwards, the patient receives a locking AO solid femoral IM nail, with regular X-ray follow-ups, what allows us to verify increasing bone neoformation that ends up in the corticalization of the lengthened area and, finally, we get repair and healing in the bone defect 12 months after the surgery (Figure 4). At protracted follow-up, five years after the distraction osteogenesis process has concluded, we verify that there is no infection recurrence and that function in the right lower limb is normal.

## Discussion

Distraction osteogenesis was thought of as a likely method even in Hippocrates' times, because at that time already, they started using traction forces for the treatment of diverse fractures. However, these outcomes only can be verified when X-rays are discovered, and Codivilla is

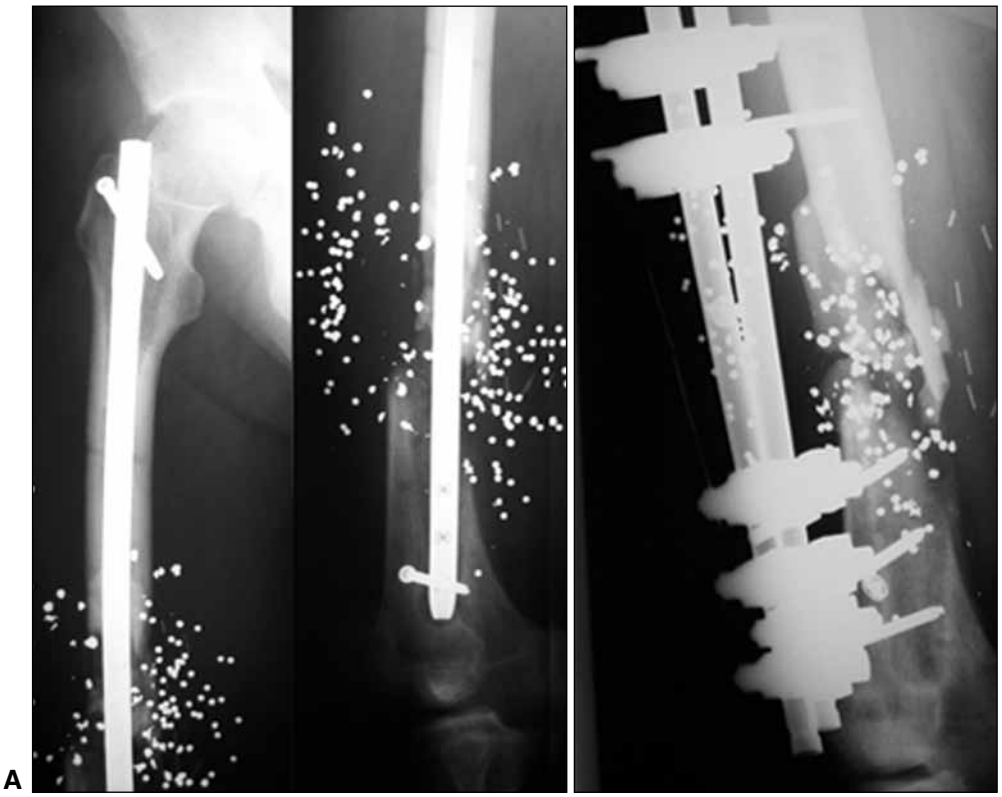


**Figure 1. A.** Open fracture type IIIC in right femur treated with AO conventional IM nailing. **B.** Twenty-four-month history infected non-union.

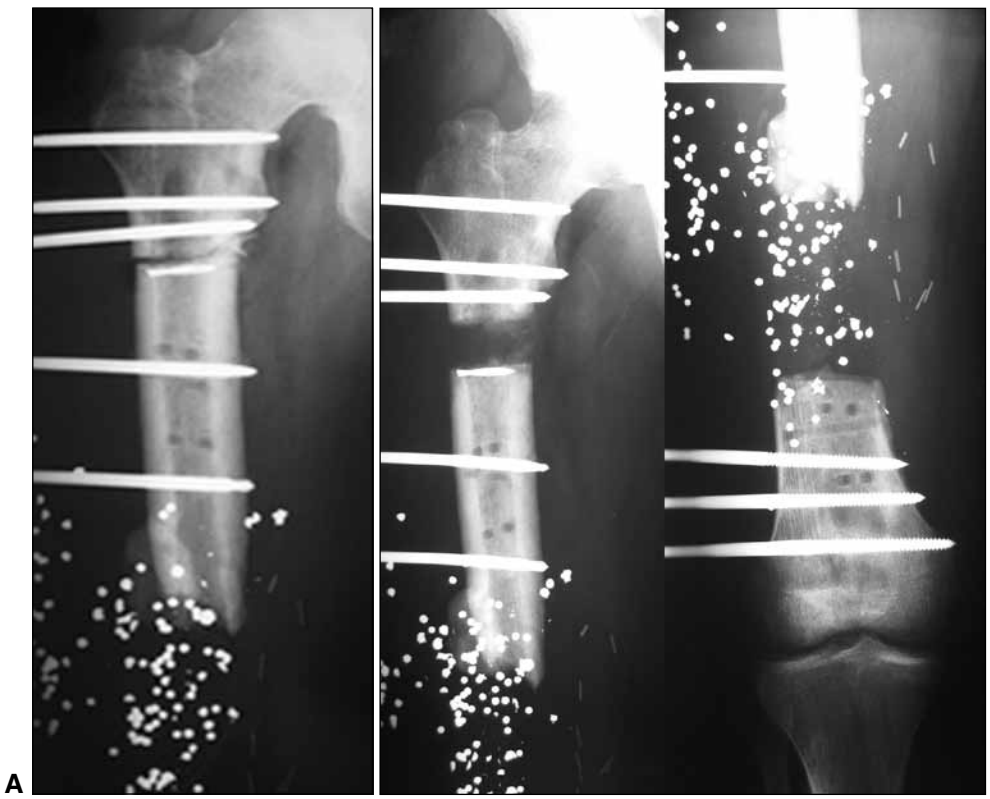


**Figure 2. A.** Resection of the infected non-union area and proximal sub-trochanteric cortical osteotomy. **B.** Femoral bone transport at week four.



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**Figure 3. A.** In situ monolateral external transporting fixator, five months after distraction osteogenesis start. **B.** Follow-up CT scan the same date.

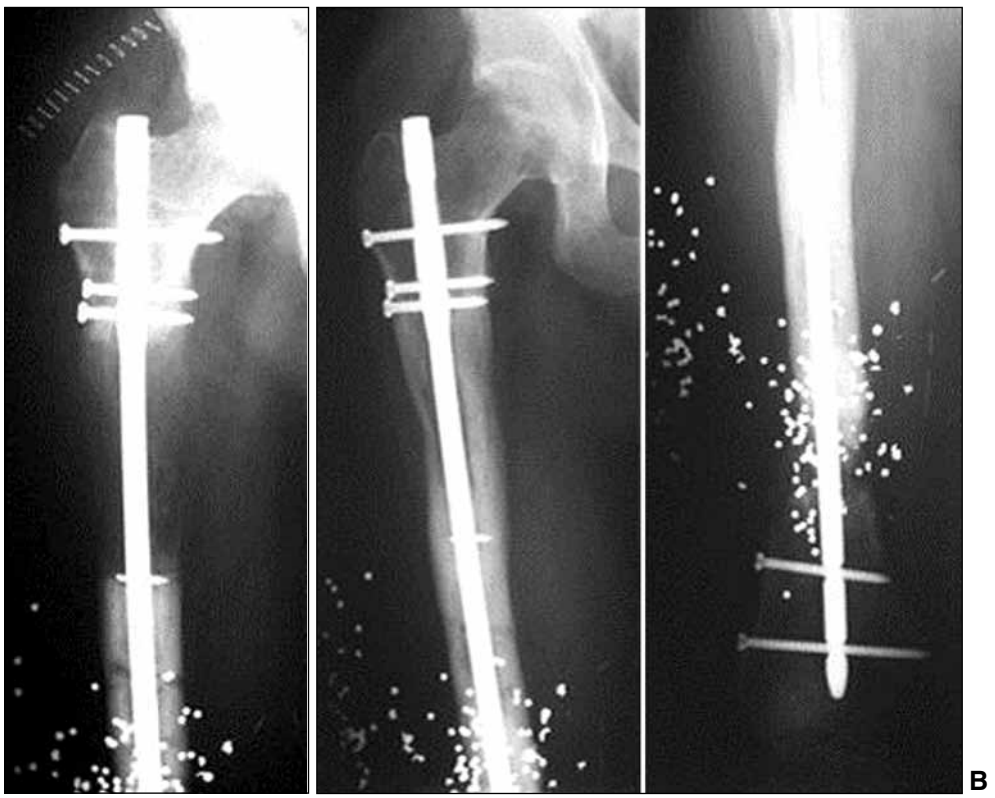

**Figure 4. A.** Postoperative follow-up of stabilization with AO solid IM nail. **B.** X-ray follow-up with corticalization of the distracted area at month 12.

considered the forerunner of this reconstructive procedure.[9] However, it is Ilizarov, from Kurgan, Siberia, Russia, who by numberless experimental and medical studies laid the definite foundations for this valuable technique to get bone neoformation, not only in children but also in adults, by the practical application of this natural mechanism known of as "distraction osteogenesis".[6,7]

Thus Orthopedics incorporates into its surgical arsenal a systematized and versatile procedure which allows us to repair varied bone defects, either closed or open fractures, infections, tumors and congenital conditions, taking advantage of the ability of the bone tissue to form new bone as it is progressively lengthened.

Afterwards, the use of distraction osteogeneis was adopted by maxillofacial surgery with excellent outcomes, especially for the treatment of congenital malformations.[10]

Among the traumatic injuries that frequently cause bone defects we can mention open fractures, which always pose an enormous challenge because they face us with very complex injuries due to the high energy mechanisms they are caused by.

This case is that of a femoral open fracture type IIIC with arterial injury worth repairing, as stated by Gustilo and Anderson.[11] For this reason, the injury is initially treated with surgical toilet, tetanus vaccination, parenteral antibiotic prophylaxis, external fixation and arterial-venous repair, procedures that are followed by AO conventional locking IM nailing as definite stabilization method. However, in spite of a correct treatment, the patient develops an infected non-union.

Infected non-union is the complication most difficult to solve among those in the conditions of the muscle-skeletal system; therefore, it is here where distraction osteogenesis can prove its acknowledged reparative power. For the same reason, in the case we present here we applied the Ilizarov's principles, with complete resection of the infected area and progressive transport of a healthy bone segment which undergoes the stages of latency, distraction, neutralization and dynamization, until corticalization and healing, which conclude with the repair of the residual bone defect.

This case compares favorably to those in the published series about infected femur non-unions treated with distraction osteogenesis.[12,13]

Distraction osteogenesis can gestate bone neoformation after ample resection, which is followed by the regeneration of the resected bone by the transport of a vital bone segment accompanied by parallel growth of the soft tissues. The risk of re-infection is low because the bone worked upon is healthy, and medical and functional outcomes are good, as reflected by the conclusions arrived at in the systematic reviews and the meta-analyses recently published.[14,15]

To conclude, distraction osteogenesis is a useful procedure for repair, regeneration and healing in varied bone defects, without sacrificing other tissues. It takes a patient who is committed to a long therapeutic process, a demanding method plenty of likely complications and a surgical team experienced in reconstructive techniques and tolerant to potential failure.

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