

Staged Reconstruction of Infected Tibial Nonunion with Segmental Bone Loss: From Bone Transport to Induced Membrane Salvage

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INTRODUCTION AND AIM

Infected tibial nonunion with segmental bone loss remains a major reconstructive challenge, requiring simultaneous infection control, mechanical stability, and biological regeneration.

- **Ilizarov technique** enables osteogenesis with high union rates, even in septic environments. It uses compression, distraction, bone lengthening and deformity correction.
- **Masquelet technique** promotes graft incorporation through a biologically active membrane and is increasingly used in complex reconstructions and a reliable salvage strategy in cases complicated by infected nonunion with two stages:
 - ✓ **Stage 1:** it uses a spacer with osteoinductive and angiogenic properties, causing the induction of a membrane that envelops and contains the space
 - ✓ **Stage 2:** enables stable bone fixation with the removal of the spacer and bone grafting

This study aims to **report a staged strategy combining both techniques** in a severe case complicated by infected nonunion.

METHODS

Identification: 25-year-old male

Presentation: polytrauma following an aircraft accident, presenting with a Gustilo–Anderson IIIA open and comminuted distal tibial fracture with segmental bone loss.

Management:

- **Temporary external fixation** (figure 1).
- **Definitive treatment included two phase transport** (figures 2 and 3):
 - ✓ **Fixator removal, tibiotalar arthroscopic arthrodesis, and bone transport using circular external fixation** with proximal tibial corticotomy and bloc resection.
- ✓ In a second stage, an antibiotic-loaded cement spacer was used due to signs of infection associated with distal tibial open fracture.
- ✓ **Docking site management** included autologous bone grafting, compression, and stabilization with the Ilizarov system.

However, **after almost one year, evolution was complicated by infected nonunion** (figure 4), which motivated a second phase of revision and limb salvage surgery.

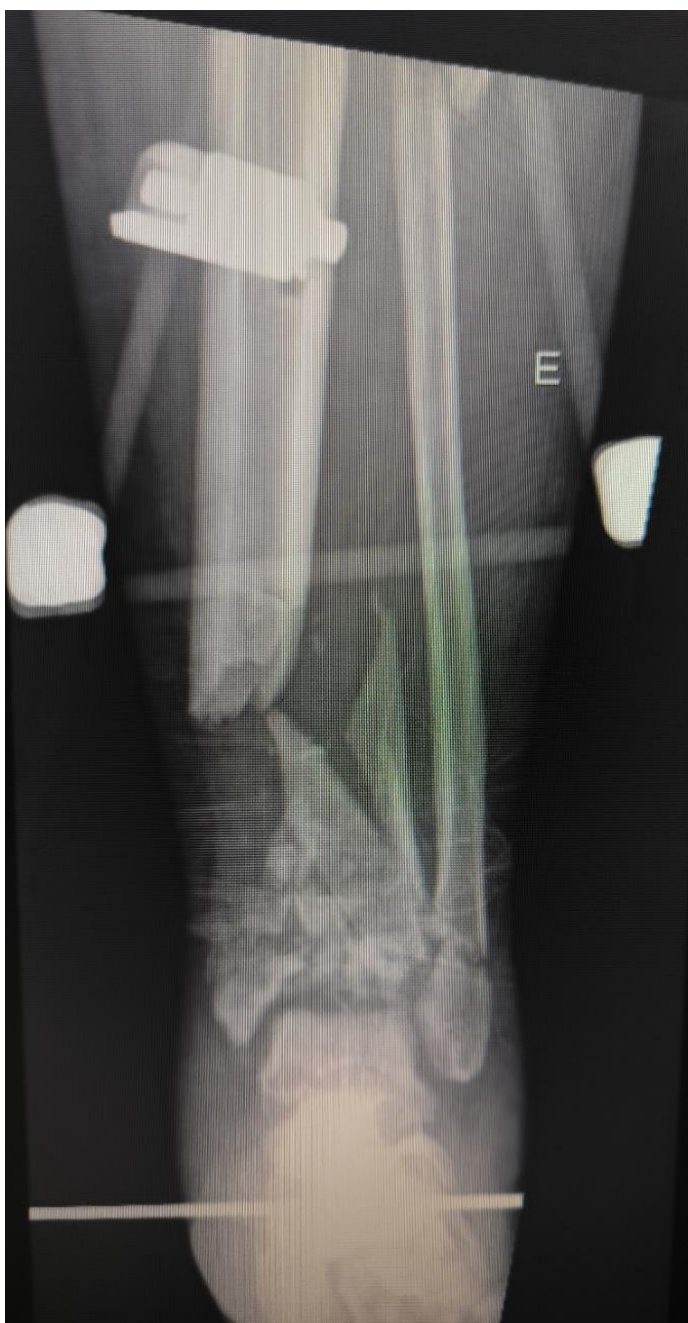


Figure 1: External fixation

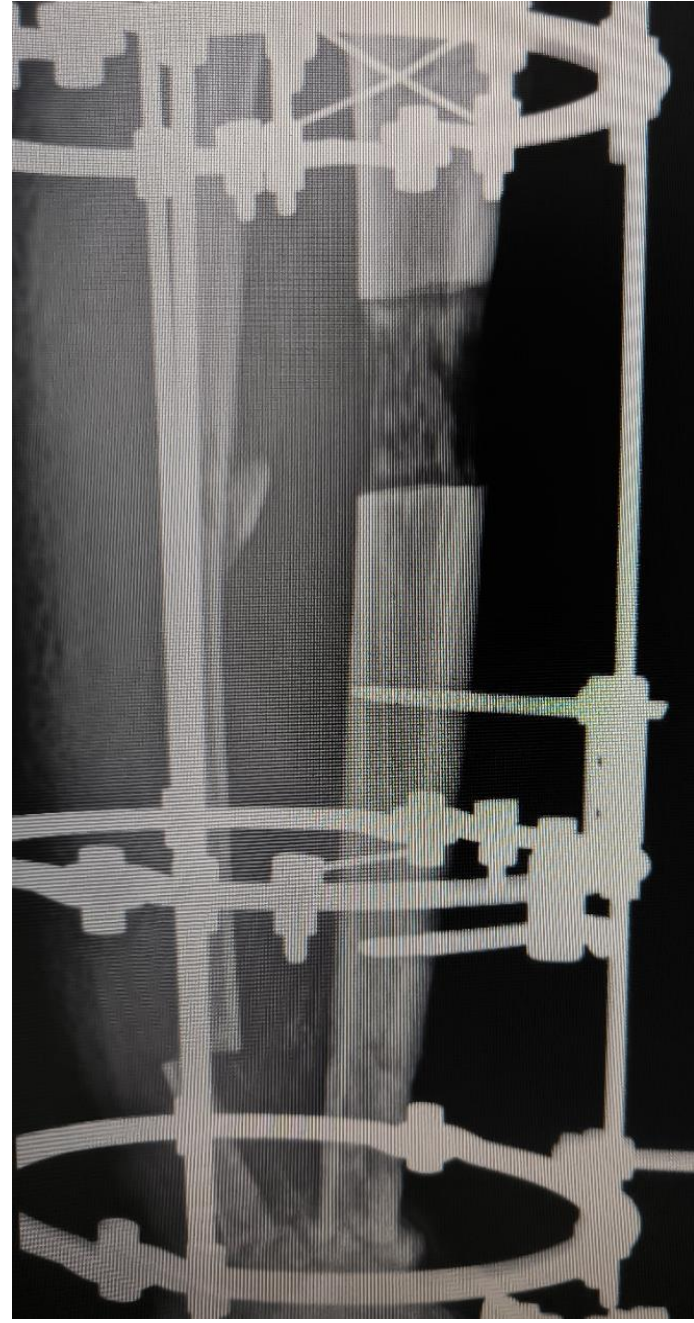


Figure 2: Transport with Ilizarov



Figure 3: Transport with Ilizarov

RESULTS

Revision surgery included radical debridement and arthrodesis using a retrograde intramedullary nail (IM) augmented with antibiotic cement-SAFE NAIL (figure 5).

Segmental defect reconstruction was then performed using a two-stage induced membrane technique (**Masquelet**).

- ✓ **Stage 1:** involved debridement and placement of an antibiotic cement spacer.
- ✓ **Stage 2:** the spacer was removed and replaced with autologous bone graft combined with local antibiotic therapy – *Cerament G*.

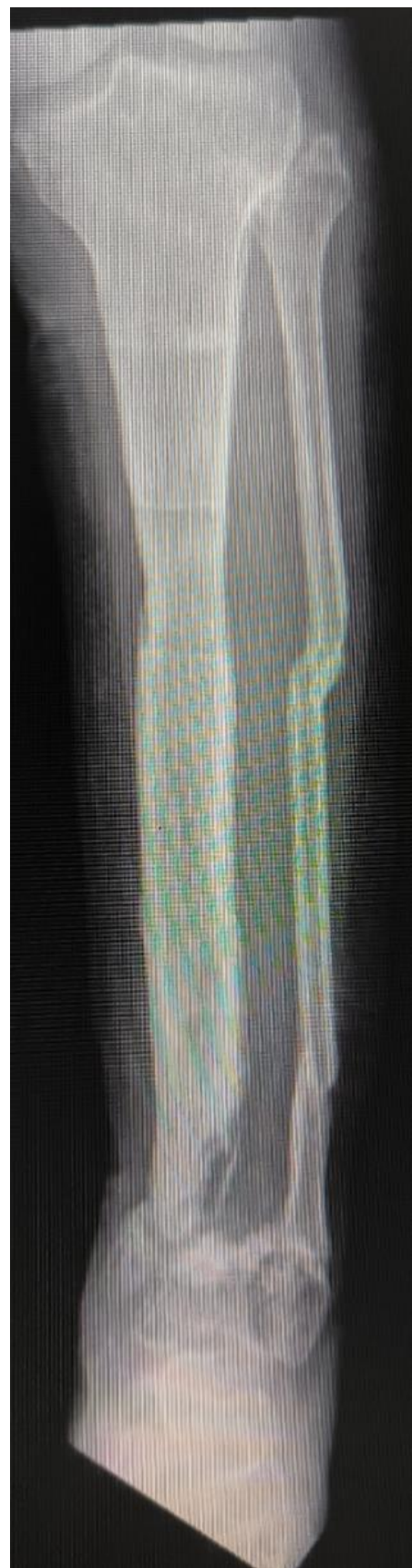


Figure 4: Infected nonunion



Figure 5: Arthrodesis with IM nail

A well-vascularized induced membrane developed, enabling biological reconstruction, with progressive consolidation of the defect.

- At two-year follow-up,** the patient was:
- ✓ Pain-free
 - ✓ No evidence of infection recurrence
 - ✓ Unassisted ambulation without assistive devices (figures 6 and 7).



Figure 6: Posterior ankle view



Figure 7: Lateral ankle view

CONCLUSION

This case illustrates the challenges of managing infected tibial nonunion with bone loss and highlights the complementary roles of bone transport and induced membrane techniques.

This case shows that a **tailored, staged approach integrating mechanical and biological principles may optimize outcomes in complex limb reconstruction.**