Case 34: Spatial Frame Correction of an Infected Distal Metaphyseal Tibial Nonunion/Malunion

Daniel Schlatterer

Contents

D. Schlatterer (✉)
Orthopaedic Trauma, Atlanta Medical Center, Atlanta, GA, USA
e-mail: danschlatterer@yahoo.com

Abstract

This case demonstrates the advantages of a spatial frame to correct a distal tibial malunion/nonunion. In this particular situation the patient presented with a history of infection after a failed internal fixation procedure. He developed drainage and had hardware removal, debridement, and antibiotics. He was referred to our institution a year later complaining of pain and inability to bear weight. In the space of 4 months, the deformity was corrected with a fibular osteotomy, spatial frame to the tibia, and gradual correction.

1 Brief Clinical History

This 32 year old male sustained an extra-articular distal tibia fracture (fibula fractured as well) after a motor vehicle collision. He was referred to our hospital a year later for a malunion and painful hardware (Fig. 1a, b). Open reduction and internal fixation was performed at the initial time of injury. The tibial plate was removed shortly thereafter due to drainage and suspected infection. In the ensuing months he continued to have pain and a progressive deformity. Upon presentation to our institution, the fibular plate was nearly through his skin distally. The varus and recurvatum deformities measured 17 ° and 30 °, respectively. Deformity correction with a spatial frame required 10 weeks, followed by 2 weeks in a short leg cast, and then a walking boot for 4 weeks. 2 years later he continues activities as tolerated without further issues (Fig. 6a, b).

2 Preoperative Clinical Photos and Radiographs

See Fig. 1.

S.R. Rozbruch, R.C. Hamdy (eds.), *Trauma/Foot and Ankle*,
DOI 10.1007/978-3-319-18026-7_193

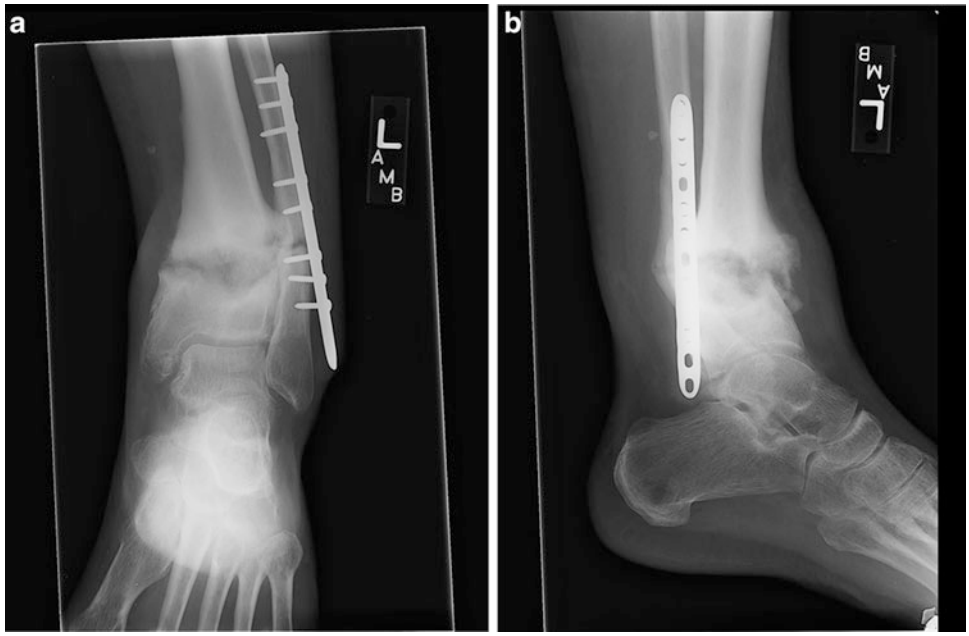

Fig. 1 (**a**) Anteroposterior radiograph at time of referral to our institution. (**b**) Lateral radiograph corresponding to Fig. 1a

3 Preoperative Problem List

1. Nonunion/malunion of distal tibia and fibula
2. Painful fibular hardware
3. History of tibia infection

4 Treatment Strategy

At the time the patient presented to us, his tibial incision where a plate was placed and subsequently removed was well healed. It showed no signs of active infection. The plan was to remove the fibular plate, apply a spatial frame to match the deformity, and start a gradual correction. An osteotomy of the fibula was performed in order to permit easier tibial correction. The fibular osteotomy was made proximal to the ankle syndesmosis which corresponded to the center of the tibial deformity (Fig. 3a). Given the history of wound issues, the goal was to correct the deformity and avoid further hardware placement if possible after frame removal. The primary goal was to correct the varus deformity. Consideration was given to more correction of the sagittal plane deformity, but this would have required soft tissue releases posteriorly.

5 Basic Principles

Our pre-operative infection workup, including clinical exam and laboratory studies, was negative for infection. The radiographs appeared to have some degree of nonunion so an attempt at gradual correction was decided upon. If the tibia did not begin to correct after several weeks, then a formal osteotomy in the operating room would be completed. The goal was to avoid a tibial osteotomy and any further violation to the tibial soft tissues if possible. The patient had been non-weight bearing for some time. The frame was designed to allow full weight bearing. The proximal tibial segment had two full rings and two 6 mm hydroxyapatite-coated half pins per ring. Two pins were in the sagittal plane, and the other two were placed as far as possible towards the coronal plane. The distal segment had a full ring and a foot plate. Multiple wires were placed similar to the half pins with the goal of a wide arch between wires. More than two wires were placed per ring/foot plate in case of later irritation and need to remove any wires in the office (Fig. 3a–c).

6 Images During Treatment

See Figs. 2 and 3.

7 Technical Pearls

A reference wire perpendicular to the anatomic axis of the tibia is critical for the correct application of a ring fixator (Hutson and Browner 2002). In this particular case our reference wire was parallel to the ankle joint (Fig. 2b). One must ensure that the frame rings are centered on the leg such that there is adequate room circumferentially. In Fig. 2a note the bumps behind the knee and under the foot to lift the leg. Also note the folded towels under the ring anteriorly to help

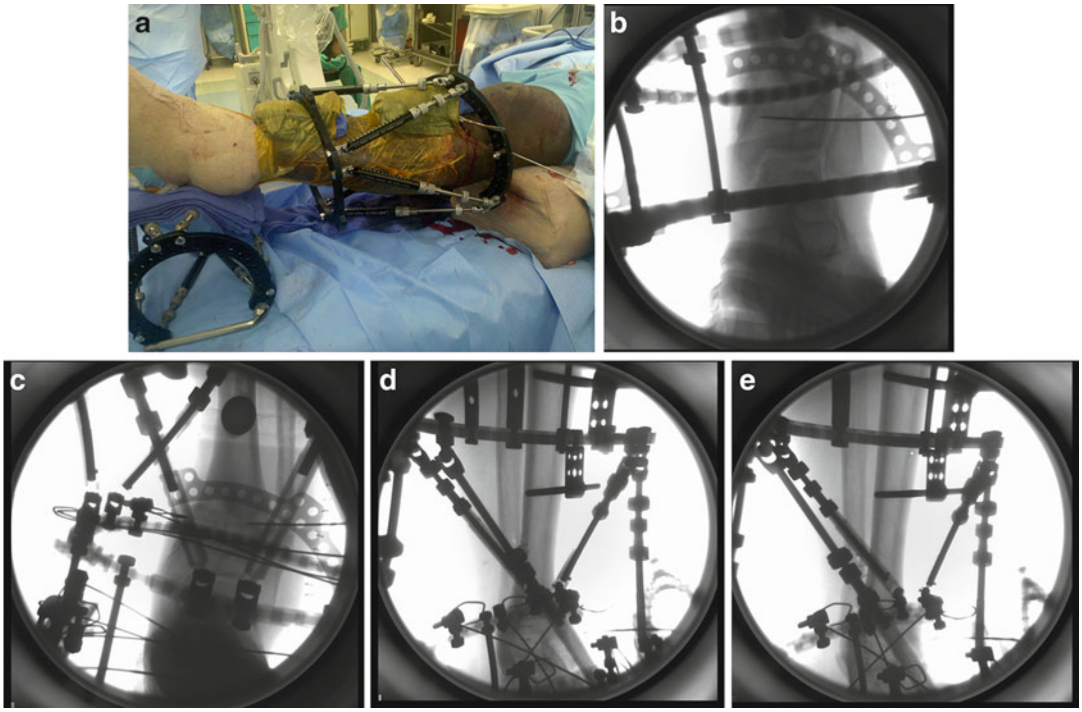

Fig. 2 (**a**) Intra-operative photo demonstrating one method of centering the leg for frame application purposes. Note the folded towels held to the leg anteriorly with a sticky drape. (This image is from a different patient but included to illustrate frame application tips). (**b**) Intra-operative fluoroscopy image demonstrating reference wire applied parallel to ankle joint and perpendicular to tibial anatomic axis. (**c**) Intra-operative fluoroscopy image demonstrating reference sphere in the image for measuring mounting parameters post-operatively. The skinny wire proximal to the ankle is not a mounting reference wire but now serves to identify the deformity origin or center of rotation of angulation (CORA). (**d** and **e**) Intra-operative fluoroscopy image. Note the improved overlap between the two posts on the ring proximal to the deformity. The ring is superimposed on itself in Fig. 2e as are the posts. This image now needs the measuring reference sphere, and then accurate mounting measurements can be completed

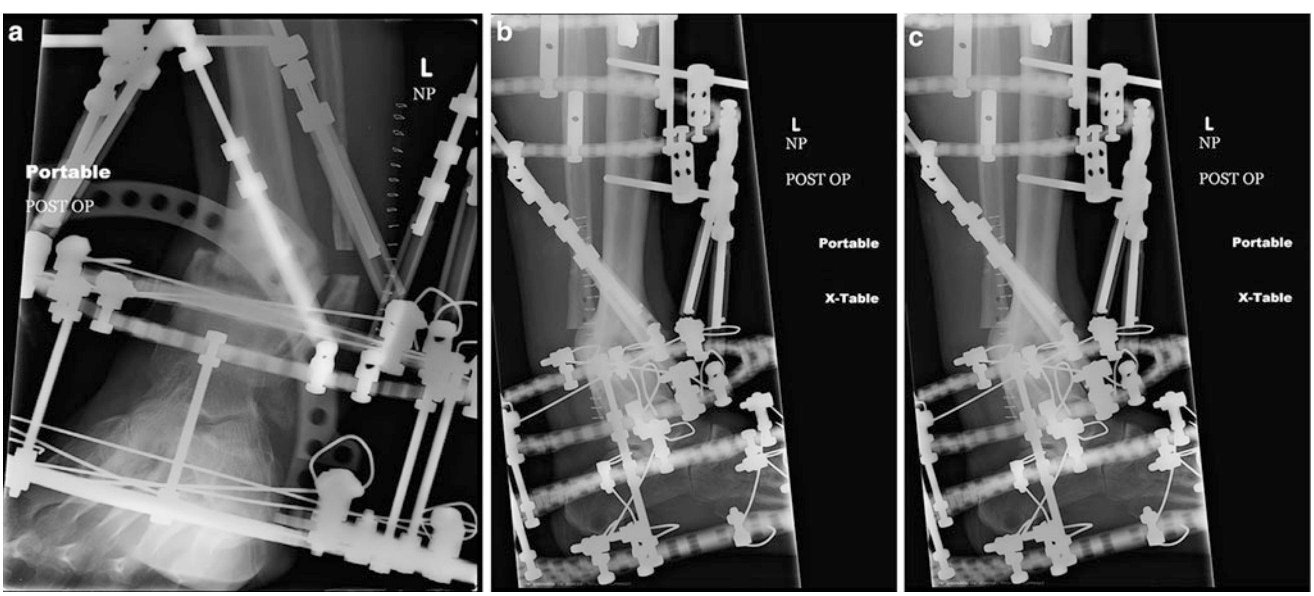

Fig. 3 (**a**) Post-operative radiograph of the ankle after frame application. Note difficulty in viewing the distal tibia. The fibular osteotomy is visible, and the gradual loss of height here indicates correction of the varus deformity. (**b** and **c**) Post-operative radiographs demonstrating two rings per bony segment and two or more points of fixation per ring

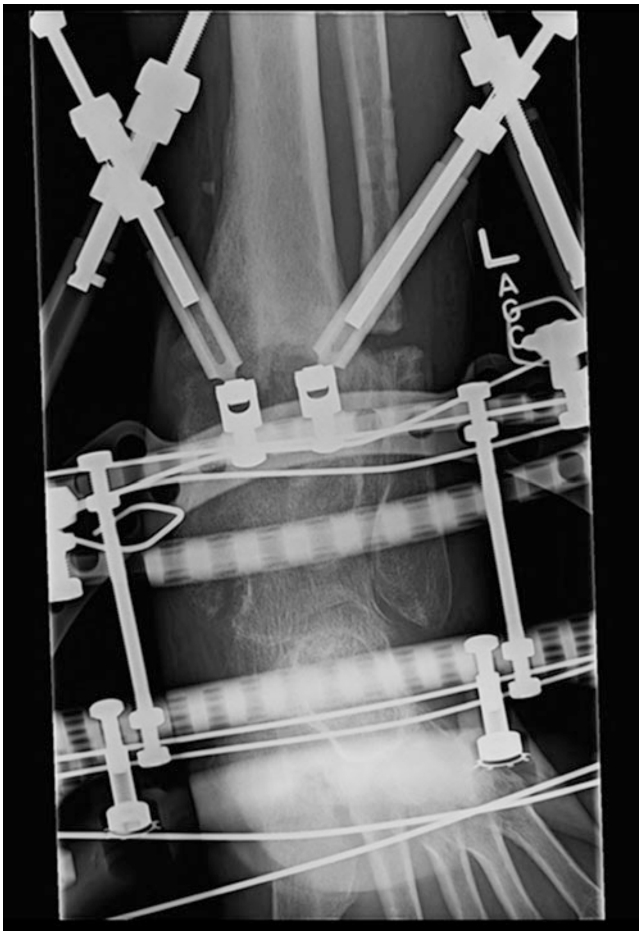

Fig. 4 Radiograph after 10 weeks of gradual correction. The fibular osteotomy space is minimal

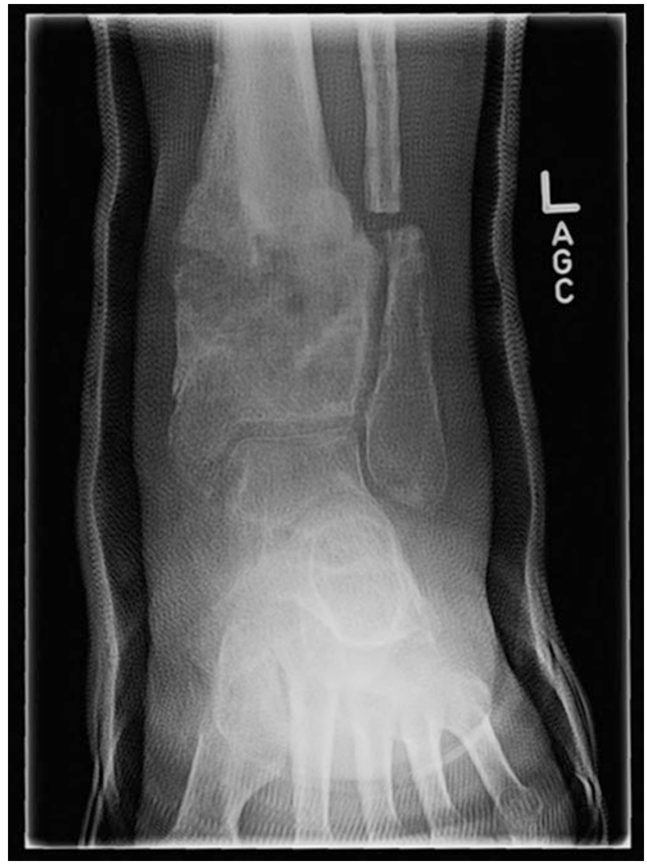

Fig. 5 Radiograph after 2 weeks of the frame off and patient in a short leg cast

center the rings. These mini bumps tend to move easily, and a sticky dressing will hold them to the leg while the first few pins or wires are placed. The other challenge in using spatial frames is accurately measuring the distance between the reference ring and the center of the deformity also referred to as the "origin" or center of rotation of angulation (CORA). This is most easily achieved in the operating room at the end of frame application. A sphere of known size is attached to the frame which accounts for any image intensifier magnification (Fig. 2c). Two other cubes are attached on opposite sides of the ring. These cubes must be perfectly overlapping on the fluoroscopic image to ensure a true anteroposterior (AP) or lateral projection (Fig. 2d, e). The reference ring needs to be superimposed as well so that any distance measured to the origin will be from the ring center (Fig. 2e). These fluoroscopic images are saved and/or printed to make measurements later on. Reliance upon post-operative images rarely results in true lateral or AP studies.

8 Outcome Clinical Photos and Radiographs

See Figs. 4, 5, and 6.

9 Avoiding and Managing Problems

The goal was to correct his deformity and avoid hardware placement after correction (Fig. 6a, b). In the office this patient tolerated removal of his frame at the 10 week mark (Fig. 4). He was placed into a short leg cast and obtained new radiographs to confirm no loss of correction. Repeat radiographs 2 weeks later revealed no loss of correction (Fig. 5). That same day in the office, the cast was changed to a walking boot. Further follow-up shows a negligible amount a correction loss. Deformity correction requires frequent office visits and radiographs to confirm the correction is progressing according to plan. This patient required a short course of antibiotics early on for pin site

Fig. 6 (**a**, **b**) Final radiographs. Patient is back to full activities. The fibular osteotomy space has increased slightly from Figs. 4 and 5. A slight loss of correction occurred

erythema. Further pin care consisted of soaking the entire leg in a kitchen garbage can filled with warm water and two capfuls each of Clorox bleach and Epsom salt. Soakings lasted 20 min 2–3 times per week. Daily showering was encouraged. Taking measurements on follow-up radiographs in the office can be difficult due to fixator parts overlapping the deformity. This can be circumvented by adding a temporary method of fixation with a strut or threaded rod and removing a strut or two for imaging purposes. In this particular case the fibular osteotomy was always easily visible. The height or space of this osteotomy was routinely measured and offered an indirect indication of deformity correction. In fact, comparison of this space between images 3a, 5, and 6a shows the shortening of this height with the frame (Figs. 3a, 4, and 5) and then slight loss of the correction in the final radiograph (Fig. 6a).

10 Cross-References

▶ Case 40: Acute Shortening and Arthrodesis Technique in Severe Irreparable Tibial Pilon Fracture

References and Suggested Reading

Hutson JJ Jr, Browner BD (2002) Applications of Ilizarov fixators to fractures of the tibia: a practical guide. Tech Orthop 17(1):1

Lark RK, Lewis JS Jr, Watters TS, Fitch RD (2013) Radiographic outcomes of ring external fixation for malunion and nonunion. J Surg Orthop Adv 22(4):316–320

Ramos T, Karlsson J, Eriksson BI, Nistor L (2013) Treatment of distal tibial fractures with the Ilizarov external fixator – a prospective observational study in 39 consecutive patients. BMC Musculoskelet Disord 14:30

Sirkin M, Sanders R, DiPasquale T, Herscovici D Jr (2004) A staged protocol for soft tissue management in the treatment of complex pilon fractures. J Orthop Trauma 18(8 Suppl):S32–S38

Wani N, Baba A, Kangoo K, Mir M (2011) Role of early Ilizarov ring fixator in the definitive management of type II, IIIA and IIIB open tibial shaft fractures. Int Orthop 35(6):915–923