Case 29: Infected Nonunion Tibia with Bone and Soft-Tissue Defect: Treatment with TSF, Intentional Temporary Deformation and Bone Transport

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Abstract

This is a case of a 22 year old male with a subacute, infected, open-type IIIB tibial shaft fracture that presented to us 12 weeks later with infection and bone and soft tissue defect. After debridement of bone and soft tissue, treatment with the Taylor Spatial Frame (TSF, Smith and Nephew, Memphis, TN) was used to implement intentional shortening, deformation, and later bone transport. This approach avoided the need for a vascularized free flap.

Fig. 1 (**a**) AP and (**b**) lateral radiographs of the right tibia upon presentation. The patient was 12 weeks status post irrigation and debridement of a type IIIB open distal 1/3 tibia and fibula fracture

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S.R. Rozbruch, R.C. Hamdy (eds.), *Trauma/Foot and Ankle*,
DOI 10.1007/978-3-319-18026-7_175

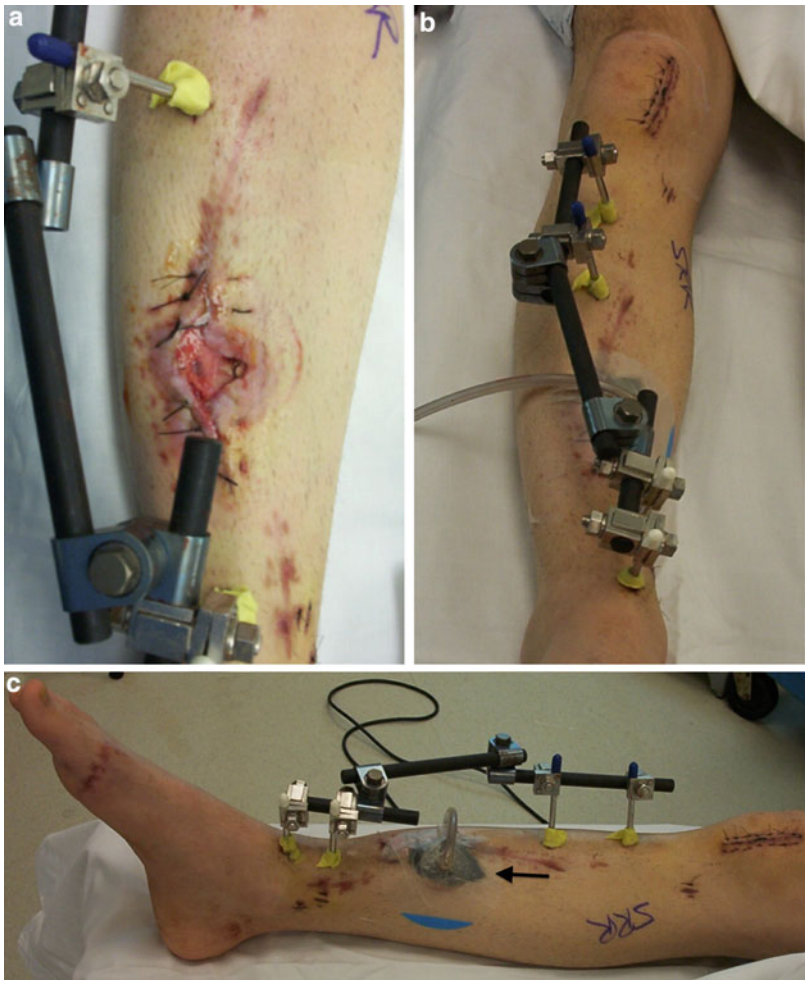

Fig. 2 Clinical photographs of the patient after initial debridement by our treating trauma surgeon. (**a**) The anterior tibial soft tissue defect measured 2 × 3 cm. The IM tibial nail has been removed. (**b**) Interim stabilization achieved with a uniplanar external fixator. (**c**) Suction-assisted closure therapy (*black arrow*) is temporarily managing the soft tissue defect

1 Brief Clinical History

This case describes a healthy 20 year old male who was in a motor vehicle accident. He suffered an open tibial shaft fracture that was treated at an outside institution with irrigation and debridement and intramedullary (IM) nailing. Eight weeks later (12 weeks after injury), the patient was transferred to our center with a diagnosis of osteomyelitis and a draining 2 × 3 cm anterior tibial wound. The patient was initially treated by our trauma colleague with removal of the intramedullary nail, debridement, and application of unilateral external fixation. Due to the bone defect, infection, and open wound, the patient was immediately referred post-operatively to our limb lengthening and complex reconstruction service for more advanced care.

2 Preoperative Clinical Photos and Radiographs

See Figs. 1, 2, and 3.

3 Preoperative Problem List

1. Open tibial shaft fracture, 12 weeks since injury
2. Draining 2 × 3 cm anterior tibial wound
3. 4 cm tibial shaft bone defect
4. Total bone loss to be determined

4 Treatment Strategy

Our treatment strategy aimed at dealing with the infected bone defect and soft tissue coverage with a desire to avoid a vascularized flap. First, additional debridement of bone and soft tissue is performed. Repeat debridement and removal of any internal hardware at the procedure also removes the nidus for infection. The use of acute shortening with recurvatum eliminated dead space and relieved tension on the anterior wound to allow for closure. Once the soft tissue lesion heals, deformity analysis is performed using the TSF schedule to correct the intentional bone deformity and to compress the

Fig. 3 AP radiograph after removal of IM nail, application of uniplanar external fixation, and minimal debridement with insertion of antibiotic cement beads (*yellow arrow*). The patient was referred to our service at this juncture

bone defect/nonunion site. A repeat long leg X-ray of the tibia once it is straight allows for revision of the initial bone loss estimate. If significant, as is in this case, a proximal tibial osteotomy with a TSF ring is used for lengthening.

5 Basic Principles

1. Removal of nonviable tissue and bone is imperative at initial debridement.
2. Reducing tension on wounds can allow for primary healing, even in traumatized tissue after adequate debridement.
3. Allow for at least 3 weeks for reporting that the wound is healed to proceed with deformity resolution. Traumatized skin heals longer than typical wounds (such as those in elective cases).
4. The temporary intentional deformation is used to close the bone and soft tissue defect and avoid the need for a flap. The TSF is essential for maintaining and subsequently correcting the deformity.
5. This technique will not work if the soft tissue defect is larger than the bone defect and there is exposed bone. It works best when the bone and soft tissue defects are similar and the bone ends are covered by the adjacent soft tissue.

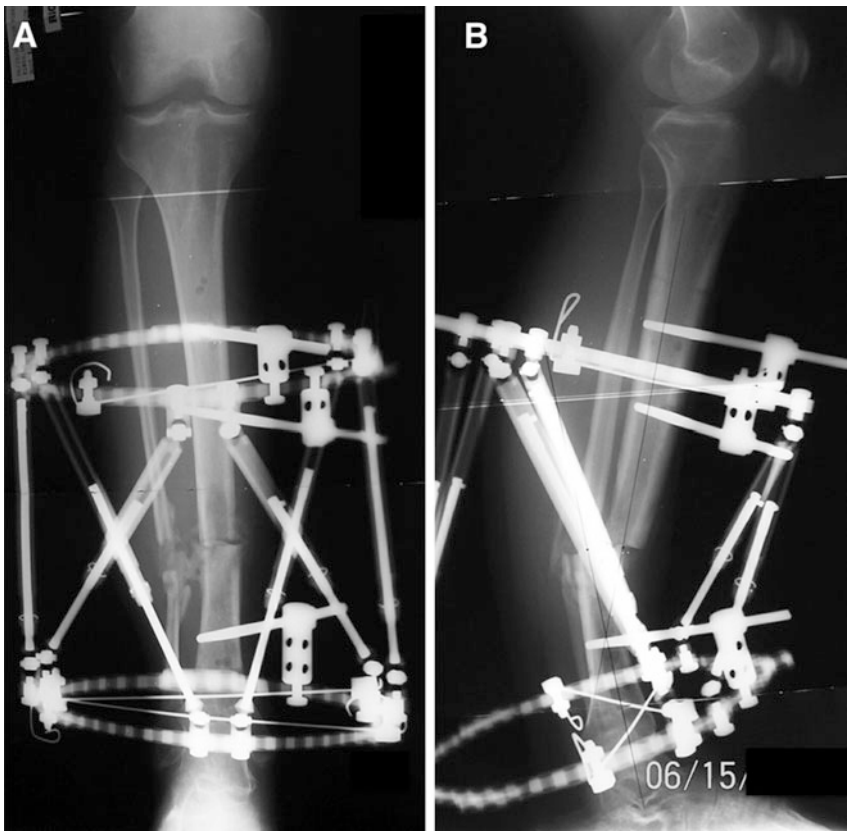

Fig. 4 (**a**) AP and (**b**) lateral X-rays of the right tibia after application of the TSF with intentional apex posterior deformity and shortening to allow for tension-free primary wound closure. Note the excision of the fibula to enable the acute shortening and deformation of the tibia

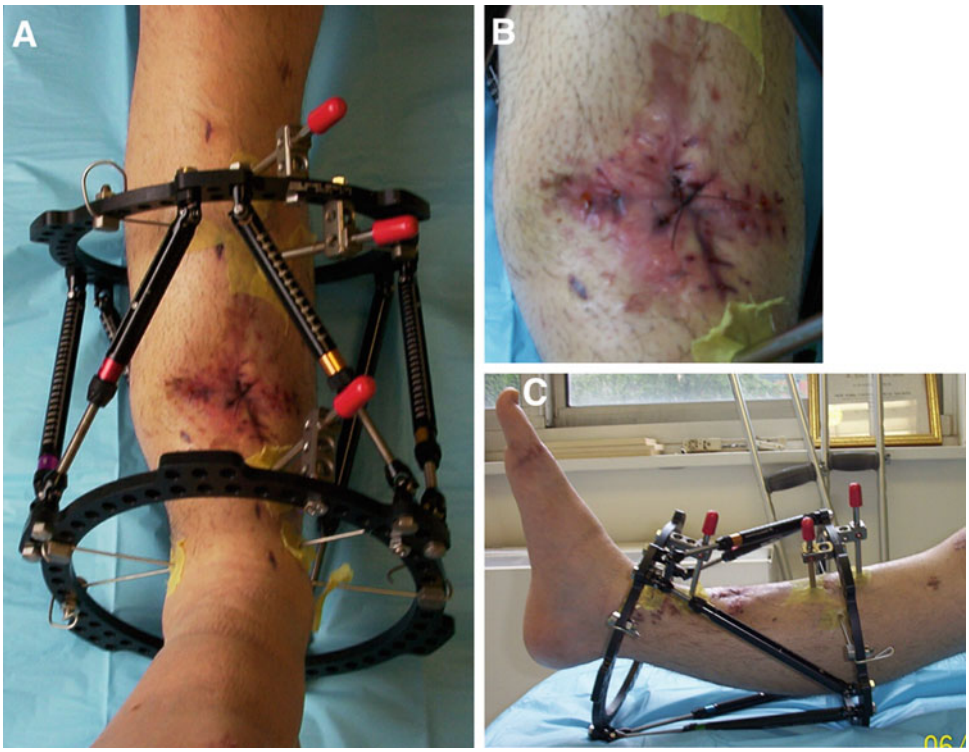

Fig. 5 Clinical photographs of the *right* leg 3 weeks after application of the TSF. (**a**) *Front view* of the leg and (**b**) *closeup view* of the anterior tibial wound. The stellate wound has healed. (**c**) *Side view* of the leg. Note the recurvatum deformity of the leg, intentionally performed to allow a tension-free wound closure. Note that the next step was gradual straightening of the tibia. Then using a 51″ erect leg radiograph, it was clear that there was a 6 cm LLD (from the shortening of the bone defect)

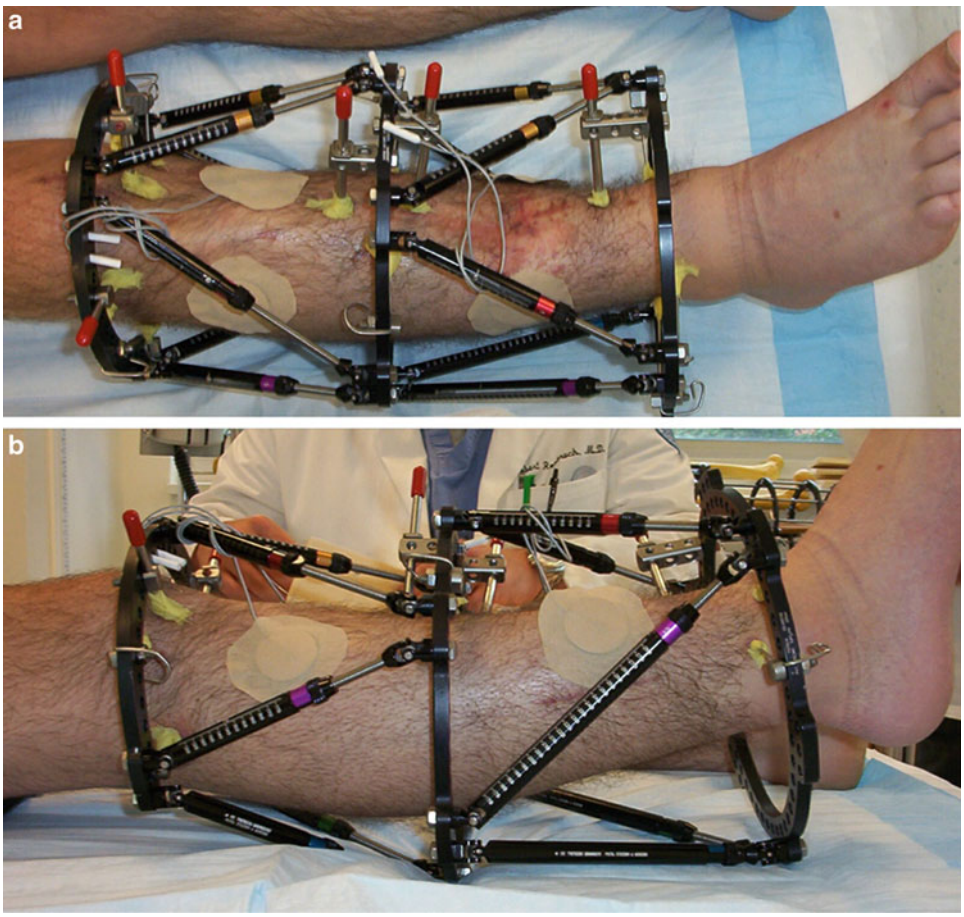

Fig. 6 Clinical photographs of the patient from the (**a**) *front* and (**b**) *side* after proximal TSF ring application and tibial osteotomy for lengthening

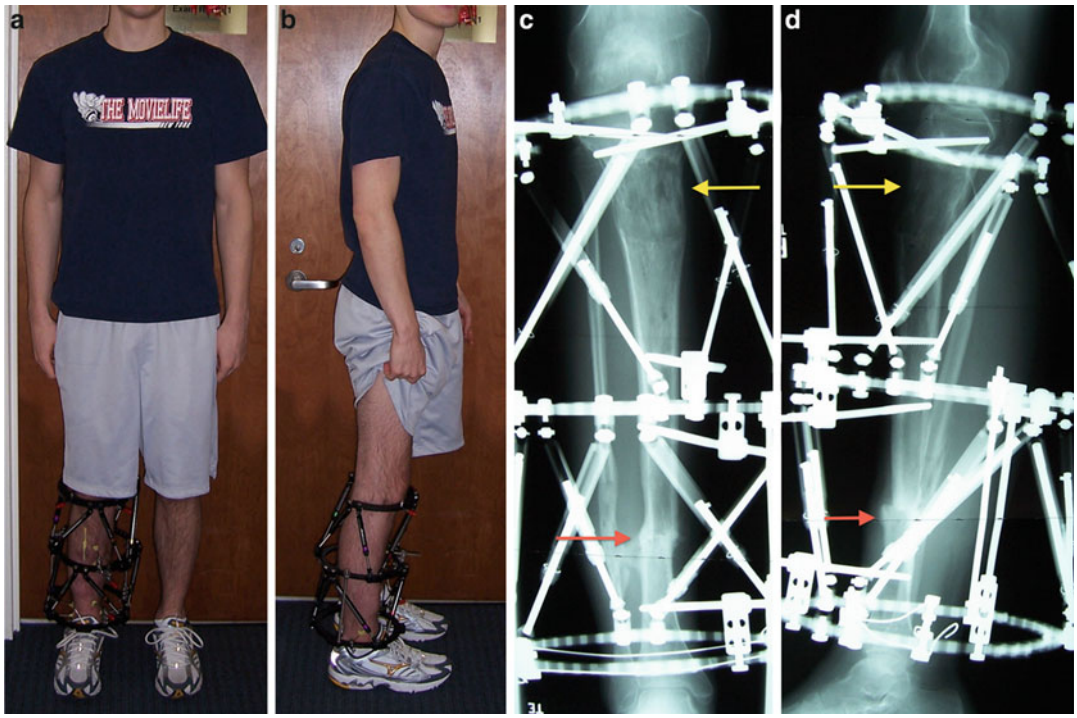

Fig. 7 Standing clinical photographs of the patient from the (**a**) *front* and (**b**) *side* after lengthening of the tibia. (**c**) AP and (**d**) lateral 36″ X-rays of the right tibia demonstrating robust regenerate at the proximal tibial lengthening site (*yellow arrows*). Distally, the tibia fracture is healing, and the deformity has been corrected (*red arrows*)

Fig. 8 Final clinical photographs of the patient from the (**a**) *front*, (**b**) *back*, and (**c**) *side* at 14 months after TSF removal. The patient reported return to rock climbing, no pain, and no muscle atrophy. Patient has 0–130° of knee range of motion (*ROM*). Ankle ROM was 20° of dorsiflexion and 30° of plantar flexion

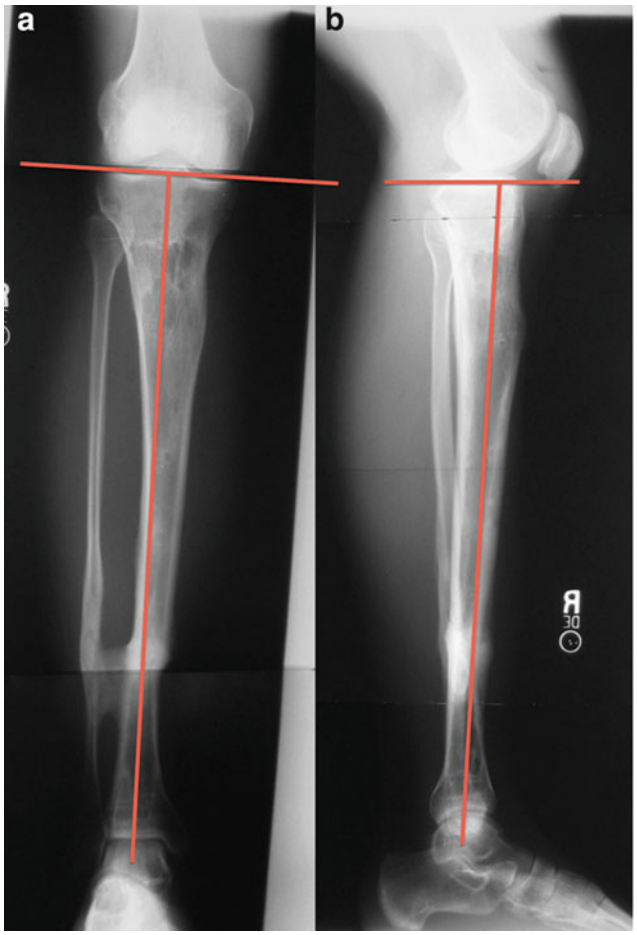

Fig. 9 Final 36″ (**a**) AP and (**b**) lateral X-rays of the right tibia 14 months after TSF removal. The patient has restoration of limb alignment; 6 cm of bone loss has been regenerated. The soft tissue has healed and infection cured. The medial proximal tibial angle (*MPTA*) measured 89°, and the proximal posterior tibial angle (*PPTA*) measured 85°

6 Images During Treatment

See Figs. 4, 5, 6, and 7.

7 Technical Pearls

1. In subacute traumatic cases that had initial attempts at ORIF, anticipate bone loss. Be prepared for proximal tibial osteoplasty for lengthening; thus plan the TSF rings at the fracture site. A two third ring may be added subsequently at the proximal tibia.
2. Check pulses before and after intentional deformation. If pulses are lost intra-operatively, restore limb alignment or lessen the intentional deformation.
3. Oval-shaped wounds that are more transverse than longitudinal will appose best with shortening and intentional deformation.
4. The addition of rotation to the deformation can additionally help appose the wound.
5. Make new transverse osteotomies of the tibia to reach bleeding and healthy bone ends.
6. Resect the fibula to allow for shortening. In this case 4 cm of fibula was resected, to allow for 4 cm of shortening.

8 Outcome Clinical Photos and Radiographs

See Figs. 8 and 9.

9 Avoiding and Managing Problems

In subacute cases, it is imperative that the treating surgeon investigates the bone viability from previous debridements. It is not uncommon to find inadequate soft tissue and bone debridements. Ensure during acute deformation that pulses remain palpable; if pulses are lost, consider performing the correction more gradually. If a small soft tissue defect remains even after the intentional deformation, a vacuum-assisted closure device may be added.

10 Cross-References

▶ Case 20: Distraction of Hypertrophic Nonunion
▶ Case 37: Hypertrophic Nonunion Distal Periarticular Tibia. Treatment with Callus Distraction Using a Spatial Frame

References and Suggested Reading

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