Case 33: IIIB Segmental Open Tibial Plafond Fracture Treated with Ankle Joint Salvage and Bone Transport

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Abstract

Stabilization of short periarticular segmental tibial plafond fractures with internal fixation is difficult. Soft tissue compromise, especially in open fractures, further complicates these injuries. Circular external fixation is a versatile tool for treatment of these complex injuries. In addition to stabilizing the fracture, ipsilateral bone transport or lengthening can be performed to treat segmental bone loss.

This article describes the treatment of an open distal tibia fracture with significant metaphyseal bone loss and soft tissue compromise. A circular external fixator (Taylor Spatial Frame, TSF) was used with acute shortening, iliac crest bone graft distally, and concommitant ipsilateral lengthening.

1 Brief Clinical History

EP is a 35 year old female who fell from a two story balcony and sustained a type IIIB open segmental distal tibial fracture. She was treated at an outside hospital with bone resection, debridement, antibiotic cement spacer, and four pin static external fixator. Six weeks later, she arrived in my clinic with an intact four-pin fixator and I scheduled her for definitive treatment the following day. During our discussion in pre-op holding the following morning she described a trip and fall the night before and "it felt like something shifted."

2 Preoperative Clinical Photos and Radiographs

See Figs. 1 and 2.

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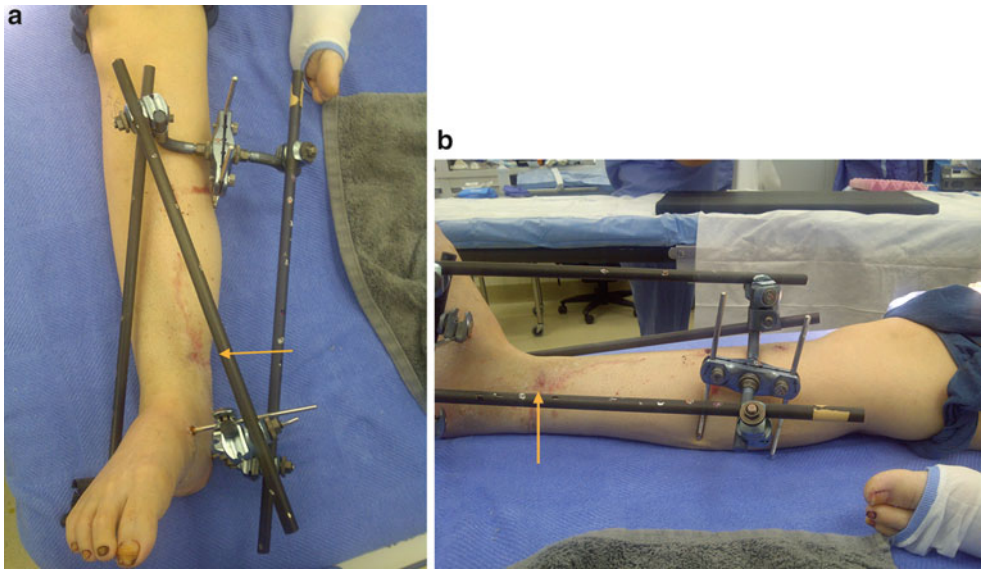

Fig. 1 (**a**, **b**) AP (**a**) & lateral (**b**) clinical view of the leg; note the proximal half pin cluster pulled out of the bone and "shifted" medially during her fall the night before surgery; note the adherent scar at the medial ankle (*arrow*)

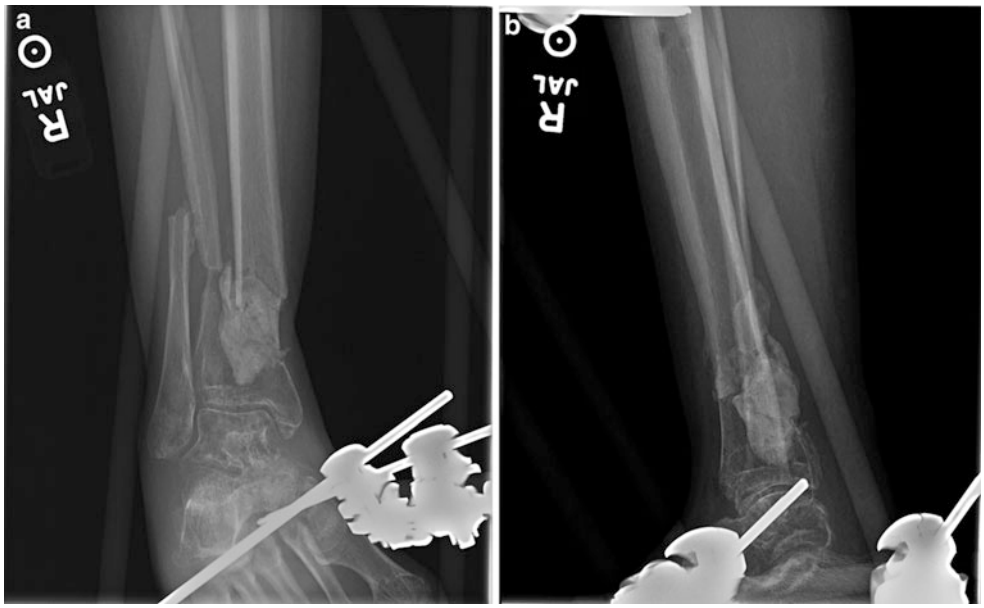

Fig. 2 (**a**, **b**) mortise (**a**) and lateral (**b**) X-ray view of the ankle; note the cement spacer and amount of tibial bone loss and shortening evident by the overlapping fibula

3 Preoperative Problem List

- Open segmental distal tibial fracture
- Tibia bone loss
- Short peri-articular segment
- Cement spacer
- Compromised soft tissue
- Need for approximately 6–7 cm of distal shortening & proximal lengthening
- Avoid ankle equinus with bone transport
- Avoid toe contractures

4 Treatment Strategy

For a multitude of reasons, I did not think internal fixation was the best option for this patient. Because of the segmental bone loss, short periarticular fragment, and compromised soft tissues, I opted for a circulator fixator.

My plan was to autograft and acutely shorten the periarticular region as much as the soft tissues would allow. This would require removing a segment of fibula. In the post-operative period, I would then use the fixator to slowly compress and dock the diaphysis into the peri-

Fig. 3 Intra-operative AP fluoro after cement spacer removal; note the amount of limb shortening as evidenced by the overlapping fibula and the residual defect in the distal segment

Fig. 4 Intra-operative AP fluoro after fibula resection; note the defect to allow for distal docking

Fig. 5 Intra-operative AP fluoro after distal tibia diaphyseal contouring, iliac crest autograft, and simulated acute shortening; note medial soft tissue defect

Fig. 6 Intra-operative lateral fluoro image after foot ring attachment; note the distraction across the ankle joint

articular segment as the soft tissues allowed. I chose this method rather than preserving length and doing a pure bone transport because the leg was already shortened, and I wanted to dock the plafond segment as soon as possible after the autograft. I wanted to avoid reopening the compromised soft tissues for docking-site bone graft once it was closed.

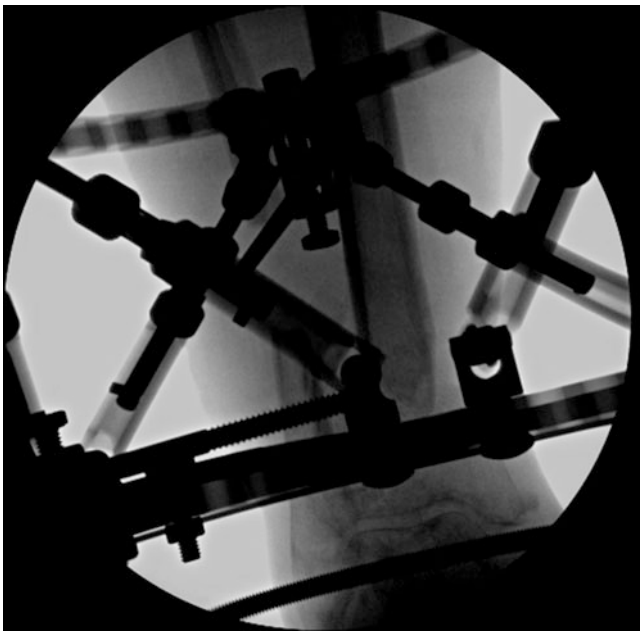

Fig. 7 Intra-operative AP fluoro image after frame completion; the distal tibia ring obscures the gap across the fracture site

Concurrent with the distal frame, I built a proximal lengthening frame and performed a metaphyseal tibia osteoplasty. To afford additional stability to the periarticular region and to stabilize the ankle during shortening and subsequent transport, I placed a static Ilizarov spanning the ankle joint. I worried about toe contractures during lengthening, so I initially pinned all five toes and attached these to the foot ring. I anticipated plafond union prior to proximal lengthening and consolidation. I planned to stage toe pin and foot frame removal at this time. I used TSF rings proximally and distally so that I could correct any residual angular deformity of the peri-articular block and proximal lengthening sites.

5 Basic Principles

I chose circular external fixation because of the compromised soft tissue envelope and the amount of bone loss distally. The fixator allowed concurrent proximal lengthening and distal compression and allowed stabilization of the foot and ankle. I acutely distracted several millimeters across the ankle and subtalar joints prior to stabilizing the static foot ring.

Proximal bone transport pulls the gastrocsoleus distally. Combined with significant distal shortening, I was concerned about ankle and toe contractures. Accordingly, I pinned the toes and spanned the ankle joint in neutral position. Attaching the circular ring at the plafond to the foot ring with threaded rods served to greatly increase the short plafond segment stability by creating a larger lever arm.

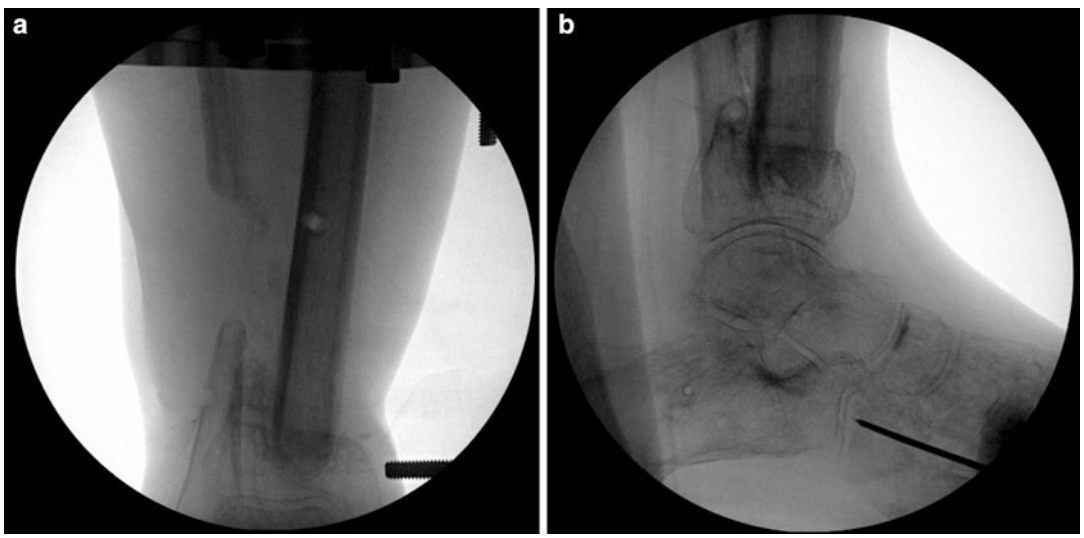

Fig. 8 (**a**, **b**) Intra-operative AP (**a**) and lateral (**b**) of the plafond at time of lower frame removal; note the osteopenia; note the preserved ankle and subtalar joint; note the retained broken wire from pinning the toes (this was asymptomatic and removed when the proximal lengthening frame was removed several weeks later)

Fig. 9 (**a**, **b**) Post-operative AP (**a**) and lateral (**b**) of the leg after proximal frame removal

6 Images During Treatment

See Figs. 3, 4, 5, 6, and 7.

7 Technical Pearls

External fixation is a proven method for fracture healing and bone lengthening. Spanning the ankle joint lengthened the short distal tibia lever arm and afforded additional stability to the plafond fragment. As well, it prevented ankle equinus during bone transport. I acutely distracted the foot ring from the plafond ring a few millimeters to protect the ankle and subtalar joints during this prolonged treatment. I pinned the toes to prevent contracture. I used Taylor Spatial Frame struts instead of Ilizarov rods at both segments to allow fine-tuning of the distal docking and the proximal lengthening sites to address any residual deformity. An option would have been to perform proximal lengthening with Ilizarov rods or "clickers" because of the physiologic bone stimulation with pulsed lengthening several times per day. The longitudinal medial traumatic wound (and neurovascular structures) precluded acute shortening beyond a certain amount. I resected enough fibula to allow the calculated shortening for docking. In an attempt to improve the biology, I placed autologous iliac crest bone graft into the plafond segment prior to wound closure.

8 Outcome Clinical Photos and Radiographs

See Figs. 8 and 9.

9 Avoiding and Managing Problems

Adequate and informed pre-operative discussion with the patient and family is imperative so they understand the scope and timeline of limb salvage. Discussing the anticipated outline of the staged surgeries and total treatment time before surgery gives them a chance to be mentally prepared for the prolonged treatment time. As well, discussing the possibilies of obstacles, complications, and unplanned procedures is a necessary component of the pre-op discussion.

Spanning the ankle joint and pinning the toes is an important part of this treatment regimen. Spanning the ankle provides additional plafond stability, allows improved mobilization, and weight bearing. Pinning the toes prevents contracture.

It is important for the surgeon to understand that plafond fixation will violate the ankle joint capsule and puts neurovascular and tendinous structures at risk. Muscle relaxers should not be used during surgery; the surgeon should take care to observe for neurovascular compromise during transosseous wire placement. Post-operatively, monitor closely for evidence of ankle joint sepsis.

10 Cross-References

- Case 30: C3.3 Pilon Fracture Closed. Ilizarov Fixation with Limited Open Reduction of Joint Surface and Distal Tibia Bridging Distraction of Ankle Joint
- Case 33: IIIB Segmental Open Tibial Plafond Fracture Treated with Ankle Joint Salvage and Bone Transport
- Case 34: Spatial Frame Correction of an Infected Distal Metaphyseal Tibial Nonunion/Malunion
- Case 35: Periarticular Distal Tibial Infected Nonunion, Ankle Salvage with Bone Transport
- Case 36: Distal Tibial Bone Defect Treated with Bone Transport Using Two Proximal Osteotomy sites
- Case 40: Acute Shortening and Arthrodesis Technique in Severe Irreparable Tibial Pilon Fracture
- Case 41: Ankle Arthrodesis with Tibial Lengthening for Failed Pilon Fracture

References and Suggested Reading

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