# Case 27: Induced Angular Deformity and Acute Shortening for Primary Wound Closure in a IIIB Open Proximal Tibia Fracture

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## Contents




**Abstract**

Treatment of open high-energy segmental proximal tibia fractures is complicated by a compromised, and often deficient, soft tissue envelope. Although soft tissue defects in the proximal third of the leg can be readily addressed with local soft tissue flaps, these come with their own functional morbidity. With induced angular deformity and axial shortening, circular external fixation can be used to concomitantly treat the soft tissue and bone injuries with primary wound closure and ipsilateral distraction.

This article describes the treatment of a high-energy open segmental proximal tibia fracture with soft tissue compromise. After initial debridement, the extremity was acutely shortened and angulated through the fracture site to allow primary wound closure. The induced deformity was statically held with a circular external fixator (Taylor Spatial Frame) for several weeks to allow adequate soft tissue healing; then, gradual angular correction was performed. The axial shortening was corrected through concomitant ipsilateral lengthening of the distal tibia.


## 1 Brief Clinical History

KD is a 31 year old male involved in a high-speed MVA where he sustained blunt chest trauma, closed head injury, and bilateral open tibia fractures. He was intubated on arrival to our facility. After resuscitation, both open tibia fractures were debrided and the right was treated with intramedullary nail. The left was splinted and wound VAC applied. Forty-eight hours later, after repeat debridement, a circular external fixator was placed on the left leg. The extremity was acutely shortened and angulated through the segmental fracture to allow primary closure of the wound. The fixator was extended to the ankle, and a distal corticotomy was performed to allow concomitant ipsilateral lengthening.


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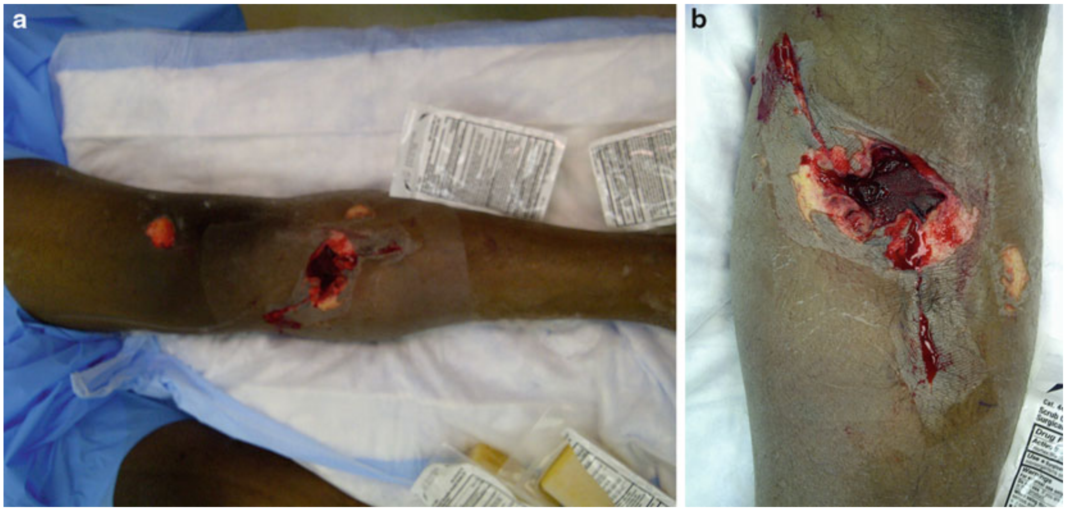


**Fig. 1** Clinical photograph of leg (**a**) and close-up photo of wound (**b**) 48 h after injury prior to second debridement and application of external fixator

**Fig. 2** AP (**a**) and lateral (**b**) X-rays of left leg showing comminuted segmental fractures


## 2 Preoperative Clinical Photos and Radiographs

See Figs. 1 and 2.

## 3 Preoperative Problem List

- Polytrauma
- Comminuted open segmental tibia fracture
- Open wound with anterior soft tissue defect

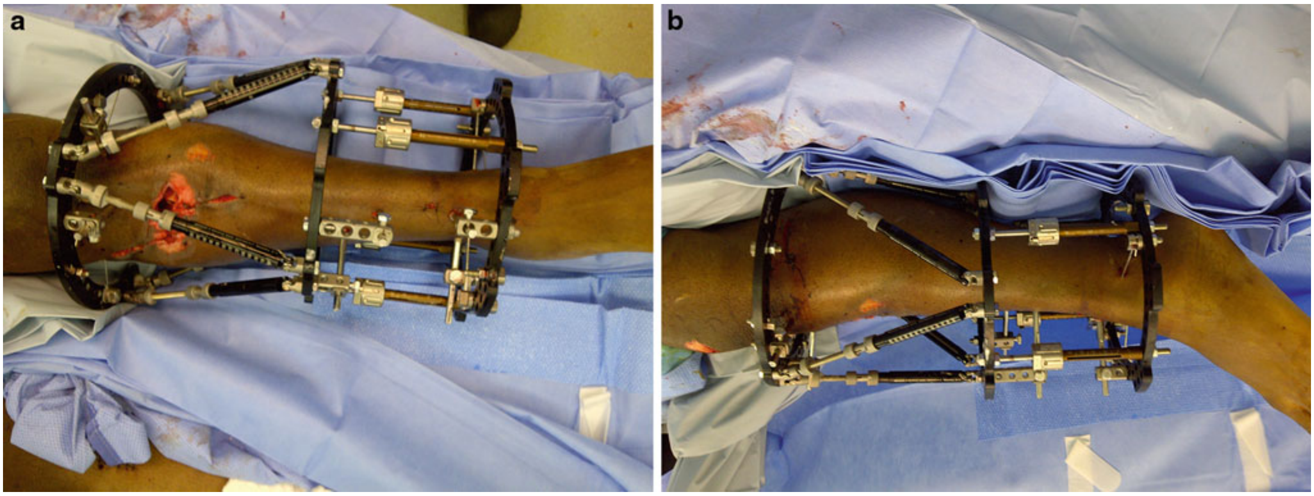

**Fig. 3** AP (**a**) and lateral (**b**) clinical pictures prior to induced deformity and wound closure; note the Ilizarov clickers distally; these were subsequently changed to TSF struts to realign the limb

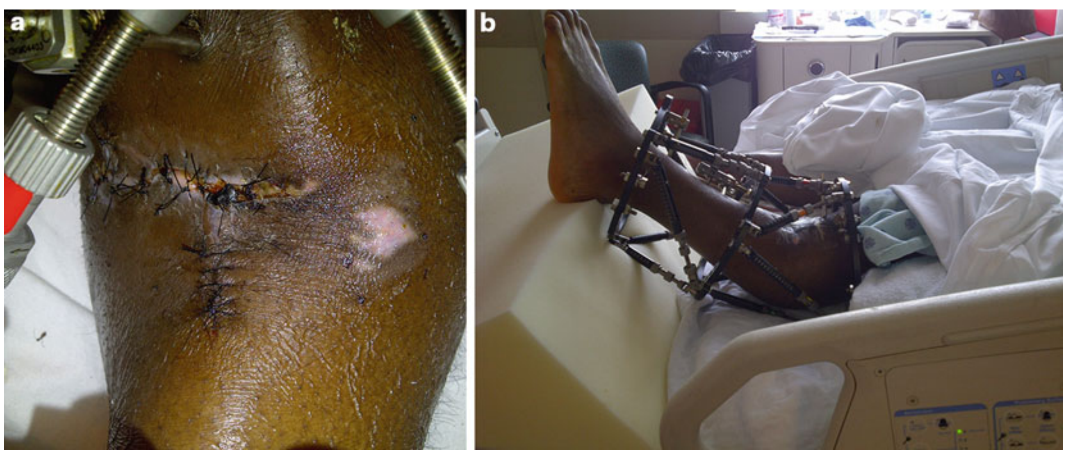

**Fig. 4** AP (**a**) and lateral (**b**) clinical pictures of leg 2 weeks after surgery; note induced deformity; note healing of primarily closed wound

## 4 Treatment Strategy

At the time of initial surgery, debridement was performed on both open tibia fractures, and the right was definitively treated with intramedullary rod. In the interest of minimizing operative time, a splint and provisional wound VAC were placed on the left. Forty-eight hours later after improvement in his clinical condition, repeat debridement was performed, and the leg was acutely shortened and angulated through the fracture to allow a tension-free primary closure of the wound. An incisional wound VAC was applied. The frame was extended distally and a corticotomy performed to allow concomitant distal lengthening after a week latency period.

The proximal frame remained statically locked in the angulated state for approximately 4 weeks to allow for primary wound healing; then, I began to slowly distract and correct the angular deformity. No bone grafting was performed at the fracture site. A removable dynamic splint was used to prevent ankle equinus. He was permitted weight bearing as tolerated, though this was complicated by the induced deformities.

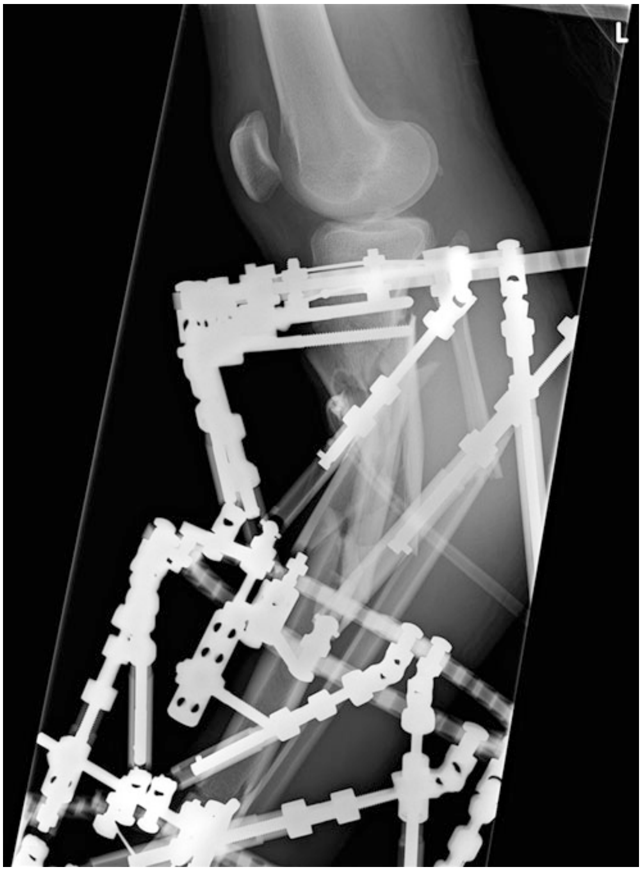

**Fig. 5** Lateral radiograph with induced deformity (axial shortening and apex posterior)

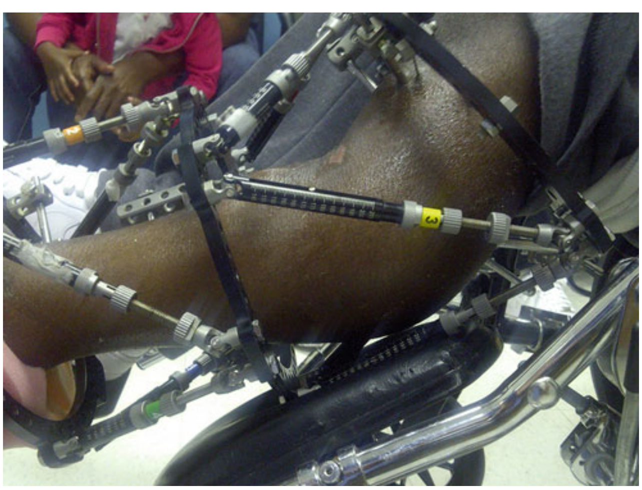

**Fig. 6** Lateral clinical view 2 weeks after initiation of proximal deformity correction

## 5 Basic Principles

Adequate debridement of devitalized bone and soft tissue is the mainstay of treatment in high-energy open fractures. Treatment options included local rotational soft tissue defect management with spanning external fixation followed by staged internal fixation with bone graft, as needed. However, after discussing my proposed treatment regimen, the family consented to the procedure herein described.

Another option would have been to correct the induced angular deformity and axial shortening at the proximal site. I opted to perform a distal corticotomy and lengthening to increase regional blood flow to the limb through corticotomy (Aronson 1994) and to shorten the total time in frame.

I used a removable anti-equinus orthotic during proximal deformity correction and distal distraction.

## 6 Images During Treatment

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

## 7 Technical Pearls

Informed preop discussion with the family is imperative. In this case, the patient was intubated during the initial treatment but upon awakening was educated on the process. Aggressive debridement and meticulous soft tissue handling are imperative. I initially built the distal lengthening segment with Ilizarov components but changed to Taylor Spatial Frame (TSF) struts to allow for better alignment. The surgeon must consider the future frame/strut position and orientation when placing pins and wires to avoid impingement as the frame and limb change shapes during treatment. An option would be to address the axial shortening and angulation through the proximal fracture site but I opted for concomitant treatment to shorten duration of time in frame. The frame should be stable enough to allow weight bearing. The surgeon should address equinus prevention during surgery planning by either incorporating the foot into the frame or with orthotics.

## 8 Outcome Clinical Photos and Radiographs

See Figs. 8, 9, and 10.

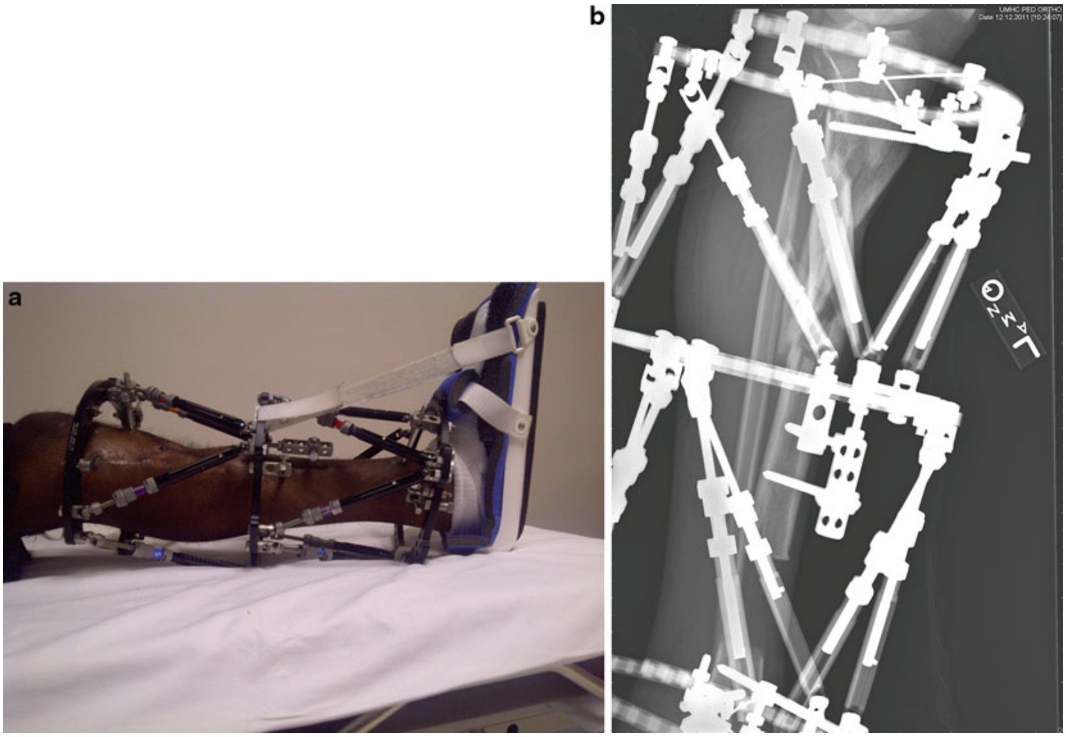


**Fig. 7** Clinical view (**a**) and lateral X-ray (**b**) of leg after correction of proximal deformity and end of distal lengthening; note the anti-equinus orthotic

**Fig. 8** Clinical picture of anterior leg after frame removal

**Fig. 9** Full-length standing radiograph after frame removal; note aligned mechanical axis (*red line*); also note the subtle residual limb length discrepancy and the loss of height below the ankle as he developed subtalar joint collapse and arthrosis in the year following injury

## 9 Avoiding and Managing Problems

The surgeon's pre-operative plan must consider the bone and soft tissue defects and have a complete reconstruction plan. A stable, versatile frame is paramount to allow weight bearing and comfort. In this case I initially used Ilizarov distractors distally but switched to TSF struts to improve alignment. Allowing adequate time for wound healing prior to gradual angular correction is important to prevent wound

**Fig. 10** Lateral X-ray of the leg after frame removal; no bone grafting was performed at the fracture site

dehiscence. I opted for distal corticotomy and lengthening to potentially avoid the need to reenter the compromised proximal soft tissue (e.g., for a bone graft). Preventing ankle equinus is much easier than treating it.

## References and Suggested Reading

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