
Case 16: Acute Shortening and Then Lengthening

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Abstract

Acute shortening and then lengthening of a long bone is a procedure that can be used during cases of bone defects and pseudarthroses. It consists of closing the (bony) defect by compressing the bone fragments followed by callus distraction. This procedure is shown in a patient who sustained an open tibial fracture, which resulted in a nonunion and limb shortening.

Acute shortening and then lengthening has several advantages: less need for local and free flaps, reduced donor-site morbidity, decreased surgical time, and fewer complications.

1 Brief Clinical History

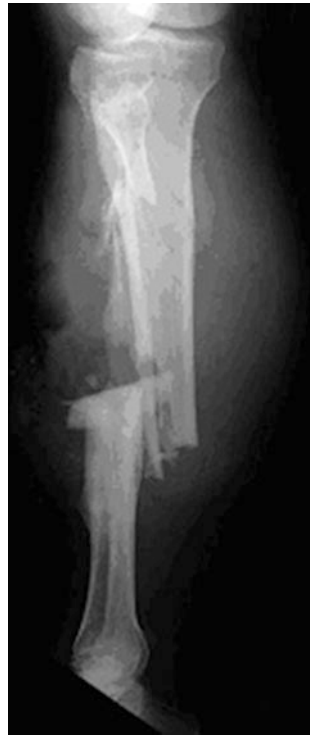
A 49 year old male was injured in a motorcycle accident. The initial diagnosis was a right open lower leg fracture (Gustilo Type IIIC) in combination with a lateral tibial plateau fracture. Primary treatment consisted of soft tissue debridement, tibial shortening, screw fixation of the tibial condyle, mounting of a monolateral external fixator, and temporary skin grafting. Five months later X-rays showed no fracture healing. In addition, total shortening of 4.7 cm (1.85 in.) was present in the lower limb – 2.5 cm (1 in.) of which occurred from a previous acetabular fracture that was treated with a total hip arthroplasty (THA).

2 Preoperative Clinical Photos and Radiographs

See Figs. 1 and 2.

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Fig. 1 Pre-operative X-ray AP view, open comminuted right midshaft tibia and fibula fracture (Gustilo Type IIIC). In addition, there is a fracture of the lateral tibial plateau



3 Preoperative Problem List

1. Nonunion of the open lower leg fracture (Gustilo Type IIIC) 5 months after injury
2. 4.7 cm (1.85 in.) shortening of the right lower limb (1 in. shortening due to right THA after acetabular fracture)

4 Treatment Strategy

- (a) Limb salvage consisted of soft tissue debridement and tibial shortening at the fracture site. The tibial shaft was stabilized initially with a monolateral external fixator, and screw fixation was performed for the tibial condylar fracture. Additionally temporary skin graft was added to cover the soft tissue defect.
- (b) Indication for bifocal callus distraction of the right tibia using a circular frame was established to achieve lower limb equality. Therefore the tibia was osteotomized distally and proximally, with simultaneous compression at the tibial nonunion site. One week after surgery, distraction was started – partial weight bearing was allowed.

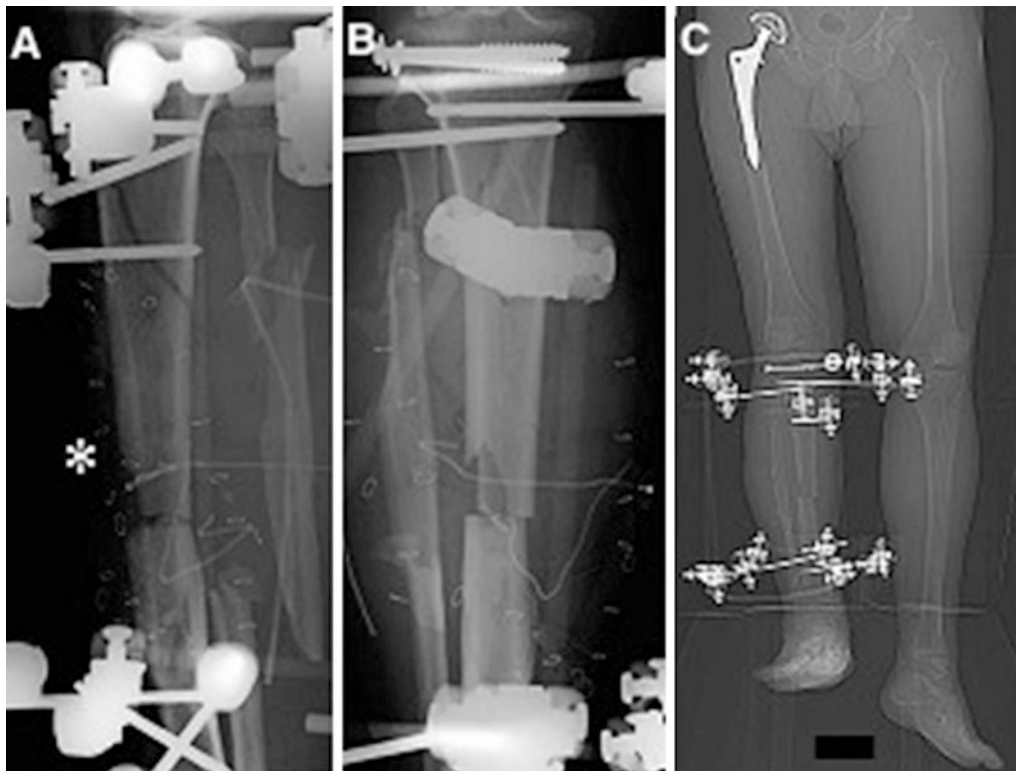


Fig. 2 Post-operative X-ray after primary treatment in AP (a) and lateral (b) view of the *right* lower limb, (c) CT scanogram with limb shortening of 4.7 cm (1.85 in.)

Fig. 3 X-ray lateral (a) and AP (b) view, bifocal osteotomy for callus distraction, 1 week after osteotomy

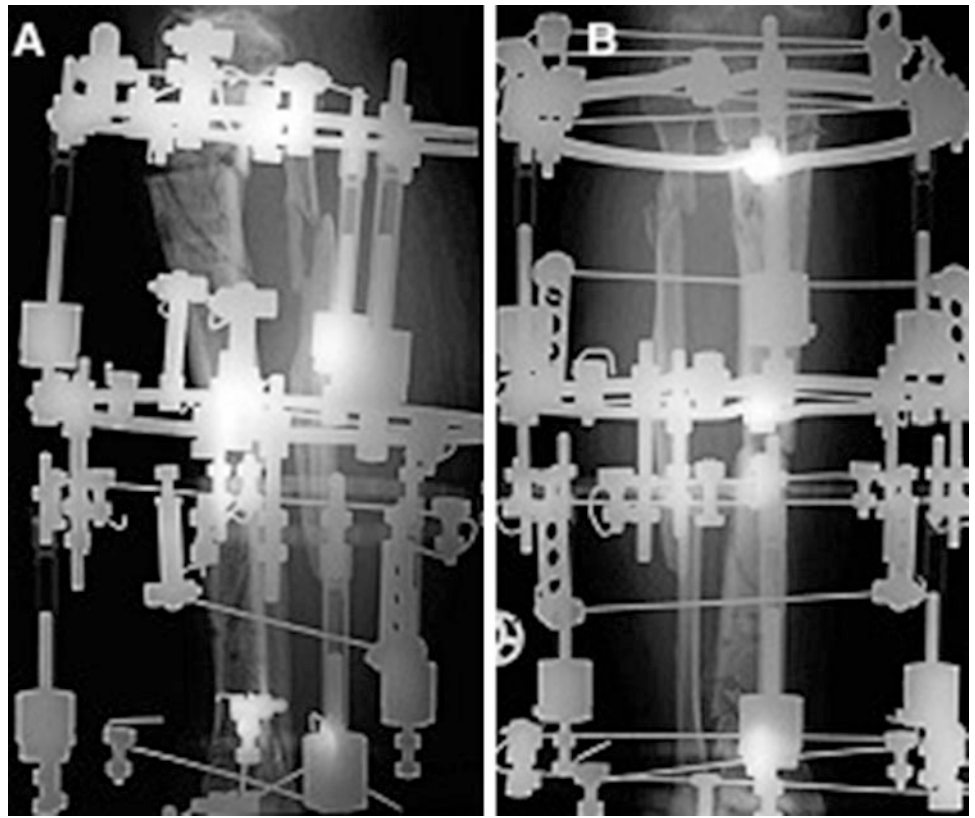


Fig. 4 X-rays after 110 days of shifting

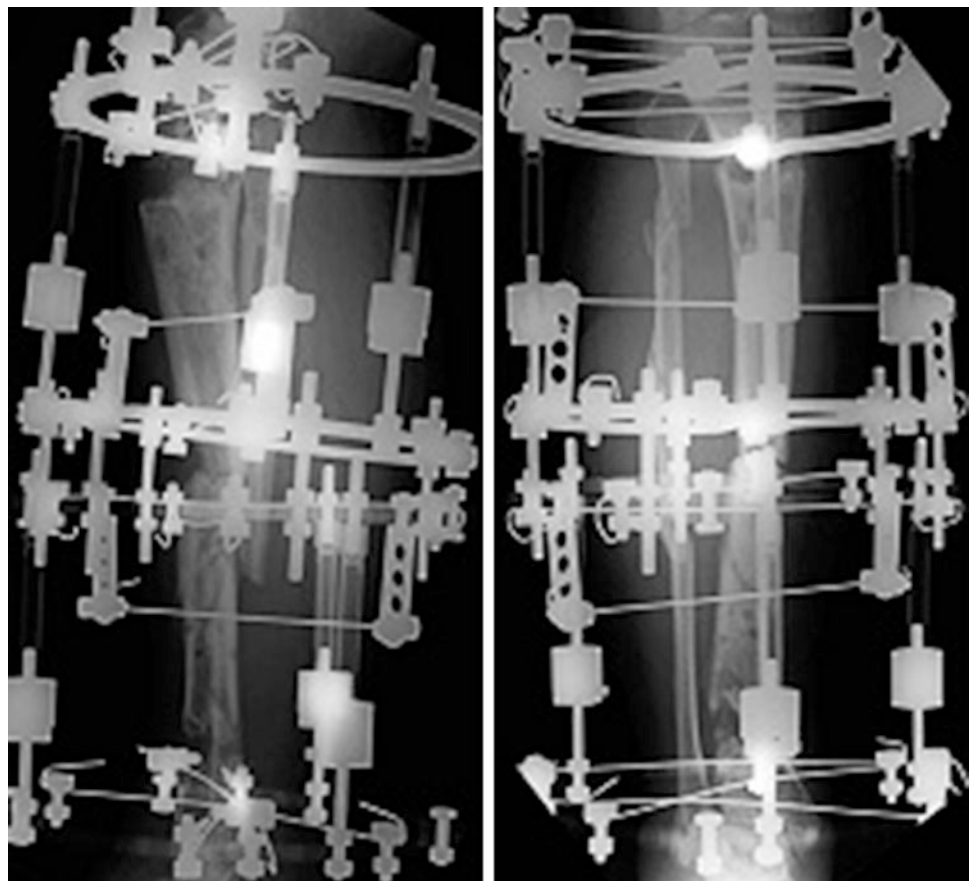


Fig. 5 X-rays after bone grafting, plating, and modification of the ring fixator



Fig. 6 X-ray lateral (a) and AP (b) view 1 year after accident, the frame was still mounted at the distal distraction gap



Fig. 7 X-ray after plate removal and conversion to a monolateral external fixator



5 Basic Principles

1. The use of **acute limb shortening** during damage control consists of closing the (bony) defect by compressing the fracture fragments. The safe amount of acute shortening before neurovascular compromise is approximately 3–5 cm in the femur and 2–3 cm in the tibia. Shortening can be greater if this is performed gradually at a rate of 2–3 mm per day. The advantages are that local viable bone is transported acutely into the large bone defect, acute realignment of the fracture is achieved with simultaneous compression of the bone fragments, and viable soft tissue is moved into the zone of injury. There is less need for local and free flaps, and this reduces donor-site morbidity and decreases surgical time because the bone and soft tissue losses are handled at the same time. Furthermore the numbers of docking site revision surgeries may be diminished, limiting adverse event rates.
2. **Distraction osteogenesis** involves three different procedures: bone transport, shortening distraction, or both.

This may be combined with the use of an intramedullary nail. Therefore, the Ilizarov technique has become the gold standard for the treatment of larger segmental tibial bone defects that require bone lengthening. Depending on the kind and size of bone defects, bone segment transport is the therapy of choice for larger defects, while distraction after optional compression is used for smaller ones.

6 Images During Treatment

See Figs. 3, 4, 5, 6, 7, 8, and 9.

7 Technical Pearls

- (a) After 140 days of distraction and lengthening of 4.8 cm (1.9 in.), the callus tissue was seen in both distraction gaps, but no callus formation was present at the docking site.

Fig. 8 Twenty-six months after accident, bony consolidation, valgus deformity of 20°, procurvatum of 40°, and shortening of 4.8 cm



Therefore, plate fixation was performed with simultaneous autologous bone grafting from the iliac crest. During surgery, the ring fixator was converted to a proximal and distal ring expanding from the proximal tibia to the supramalleolar area with four threaded bars. After surgery, skin necrosis with fistulation developed at the docking site.

- (b) Three months after plating, increased callus formation appeared radiologically at the docking site. Therefore the frame was changed expanding distally below the plate to the supramalleolar area. This distraction area had shown delayed callus formation.
- (c) Five months after plating a further injury (fall) occurred and the patient felt a cracking sensation at the plated docking site. Due to the chronic draining sinus at the docking site and the screw breakage, all implants were removed and a monolateral frame was mounted.

Additionally necrosectomy was necessary for the treatment of the persisting skin necrosis.

- (d) 26 months after injury the fracture healed with tibial deformities: valgus of 20° and procurvatum of 40°. This resulted in a shortening of 4.8 cm of the right lower leg. For acute axis alignment correction, multiple osteotomies were performed and stabilized with an intramedullary nail. However post-operatively a compartment syndrome developed and required fasciotomy. Three weeks later, skin necrosis with fistulation at the region of the distal osteotomy developed.
- (e) Two years after axis correction, the intramedullary nail was removed. The chronic infection with two draining sinuses vanished 3 months later. The range of motion in the knee joint was 0-0-120° and 0-0-20° in the ankle joint.



Fig. 9 X-rays after correction osteotomy and intramedullary nailing with an MPTA (medial proximal tibia angle) of 94.1° , an LDTA (lateral distal tibia angle) of 78.7° , and an ADTA (anterior distal tibia angle) of 110°



Fig. 10 Three months after removal of the intramedullary nail, 68 months after accident

8 Outcome Clinical Photos and Radiographs

See Fig. 10.

9 Avoiding and Managing Problems

- Axial deviation** during distraction requires correction. This can be performed, for example, by osteotomy and secondary nailing after lengthening. At that point fistulation and infection signs should be absent. In certain cases of hypertrophic sclerotic bone, passing of the reamers can become difficult.
- Severe soft tissue trauma and acute axis correction can result in an acute **compartment syndrome**. The elevated pressure in the non-expandable compartment can lead to necrosis of the nerves and muscle tissue causing ischemic contractures or even amputation. Therefore it is critical to be aware of this, detect this early, and treat it emergently with fasciotomies of all involved compartments.

10 Cross-References

- ▶ [Case 9: Limb Salvage After Massive Traumatic Femoral Bone Loss](#)
- ▶ [Case 26: Plating After Lengthening](#)
- ▶ [Case 38: Impaired Joint Motion During and After Callus Distraction](#)

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