# Tibial Shaft Fracture: Plating

Megan Young

## Contents




**Abstract**

A 12-year-old female pedestrian struck presented with an isolated injury to the right lower leg. Examination revealed a 1 cm open wound on the medial aspect of the leg directly over the fracture site consistent with a Grade 1 open fracture of the tibial shaft. Imaging confirmed a transverse fracture of the distal tibia and fibula shaft. Further inspection of the X-rays revealed an associated medial malleolus fracture. The open fracture was treated with prompt IV antibiotics and formal irrigation and debridement of the proximal and distal bone fragments. The transverse fracture pattern, distal shaft location, clean non-contaminated open wound, and exposure created to debride the bone factored in the decision to achieve absolute stability with internal compression plating technique. Alternative options for reduction and stabilization of a tibial shaft fracture in a skeletally immature child include casting, external fixation, and flexible intramedullary nails. The ipsilateral non-displaced medial malleolus fracture was managed nonoperatively in a cast. Postoperatively the patient remained non-weight bearing for 6 weeks. Both fractures healed uneventfully in anatomic alignment. The patient returned to unrestricted activity without pain.


## 1 Brief Clinical History

A 12-year-old female presented after being struck by a low-speed moving vehicle. Initial evaluation revealed an obvious deformity and instability of the right lower extremity with a 1 cm open wound on the medial aspect of the distal third of the lower leg. No gross contamination was appreciated externally, and the neurovascular examination was normal. The anterior, lateral, and superficial posterior compartments were soft on presentation. The knee was without effusion or joint line tenderness, but pain was elicited to palpation of the medial ankle. Plain radiographs confirmed a


M. Young (✉)
Children's National Medical Center, Washington, DC, USA
e-mail: MYoung@childrensnational.org




C. A. Iobst, S. L. Frick (eds.), *Pediatric Orthopedic Trauma Case Atlas*,
https://doi.org/10.1007/978-3-319-29980-8_123

transverse distal shaft fracture involving the tibia and fibula at the same level. On further inspection a non-displaced fracture of the medial malleolus was also identified. The patient received IV ancef within 3 h of the injury per open fracture management protocol. Surgery was indicated to debride and stabilize the open tibial fracture.

## 2 Preoperative Clinical Photos and Radiographs

See Fig. 1.

## 3 Preoperative Problem List

1. Open wound 1 cm/open fracture
2. Unstable distal third tibia and fibula shaft fracture
3. Ipsilateral medial malleolus fracture

## 4 Treatment Strategy

Following extension of the open wound, intraoperative inspection, and debridement of the proximal and distal fracture ends, treatment options for restoring and maintaining alignment include casting, external fixation, intramedullary flexible nails, and internal plate fixation. The exposure facilitated direct anatomic reduction of the tibia. The simple transverse fracture pattern with a small wedge fragment was amenable to standard compression plating with a six-hole dynamic compression plate. This fixation strategy provides absolute stability for direct bone healing and avoids potential loss of reduction in a cast or with flexible intramedullary nails given the distal location of the fracture. The clean, non-contaminated wound and adequate soft tissue coverage obviate the need for prolonged external fixation and known complications of pin infections, delayed union, and refracture.

## 5 Basic Principles

1. Based on mechanism of injury, consultation with general surgery trauma team for complete assessment of potential non-orthopedic injuries may be warranted.
2. A thorough orthopedic examination of all extremities and the spine is important to exclude associated injuries, especially the joint above and below the known open fracture.
3. Preoperative imaging with plain radiographs to include orthogonal views of the entire tibia and fibula is generally sufficient to visualize the fracture pattern and develop a plan for fixation. Dedicated imaging of the knee or ankle joint should be considered if incompletely evaluated on the full length tibial films or indicated based on clinical suspicion for associated ipsilateral injury.
4. Prompt initiation of intravenous antibiotics for open fracture management within 3 h and timely debridement of the open fracture site reduce potential complications of infection.

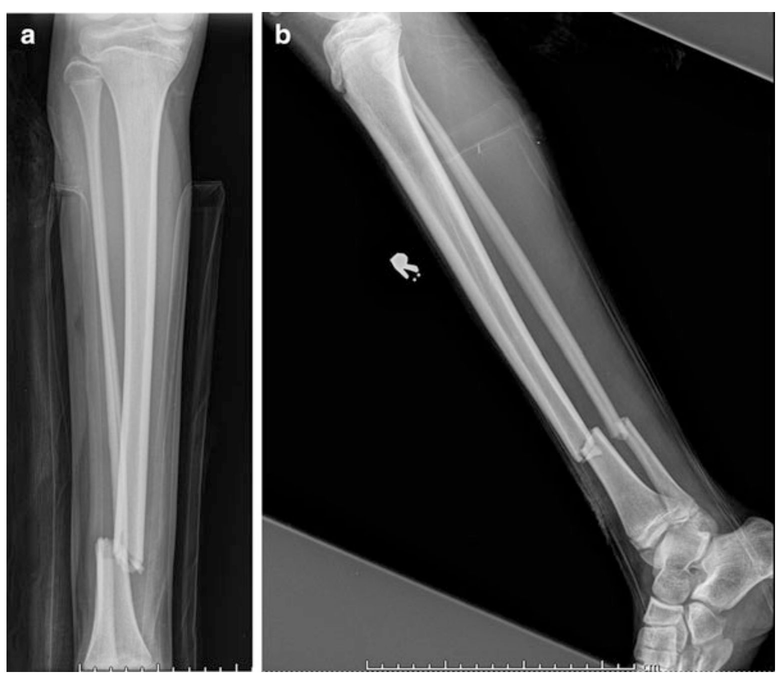


**Fig. 1** Anteroposterior (**a**) and lateral (**b**) radiographs of the right tibia show a transverse fracture of the tibia and fibula near the diaphyseal-metaphyseal junction with a small wedge fragment. An associated fracture involving the anterior colliculus of the medial malleolus is best appreciated on the lateral image

5. The optimal fixation method depends on intraoperative inspection of the fracture pattern, degree of bone loss or comminution, and soft tissue coverage.
6. Absolute stability permits direct/primary bone healing and can be achieved using lag screw and plate fixation or compression plating for simple fracture patterns with adequate cortical contact as in this case. Lag screws were unable to be used due to the transverse fracture indicating compression plating to achieve adequate stability.
7. Complex fracture patterns with bone loss or comminution require a construct that affords relative stability for indirect/secondary bone healing such as bridge plating. Indirect reduction techniques can be employed with percutaneous plating options to preserve the soft tissue envelope and periosteal blood supply at the fracture site.

## 6 Images During Treatment

See Figs. 2, 3, and 4.

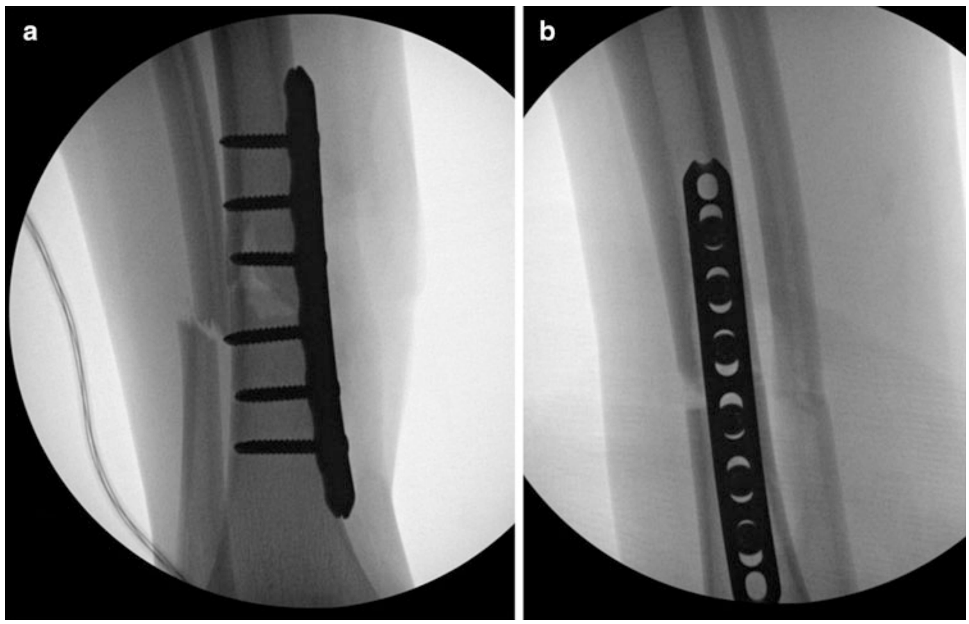


**Fig. 2** Intraoperative anteroposterior (**a**) and lateral (**b**) fluoroscopic images of the right distal tibia showing restored anatomic alignment, adequate cortices engaged with the screws through the plate, and no gapping at the fracture site with the exception of a very small anterolateral fragment removed with the open fracture debridement

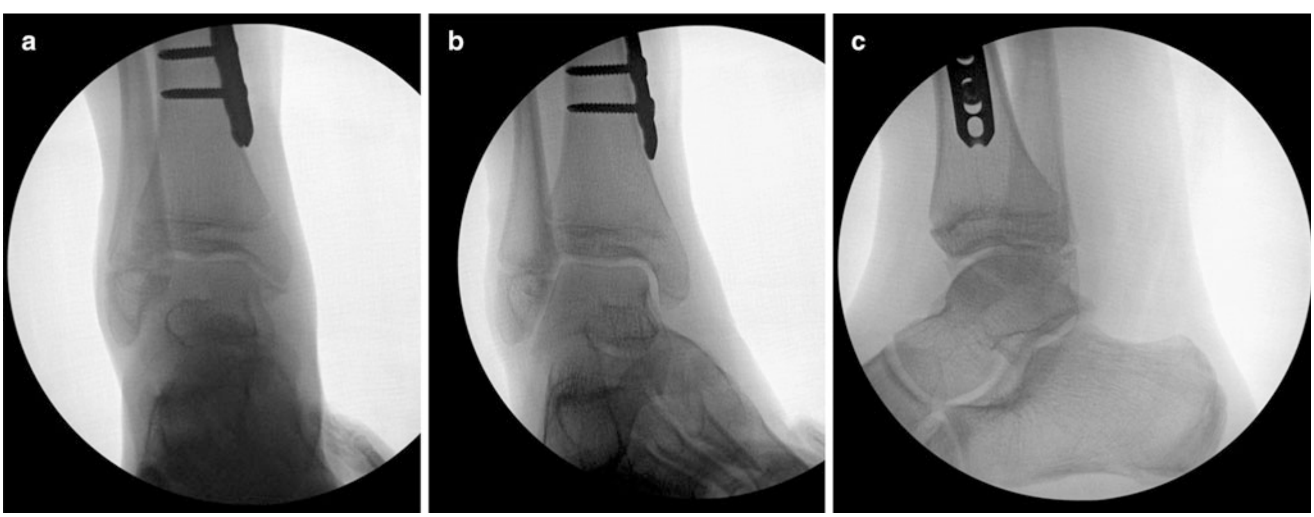


**Fig. 3** Intraoperative anteroposterior (**a**), oblique (**b**), and lateral (**c**) fluoroscopic images of the right ankle showing adequate alignment of the ankle mortise and a non-displaced medial malleolus fracture of the anterior colliculus that did not require operative fixation

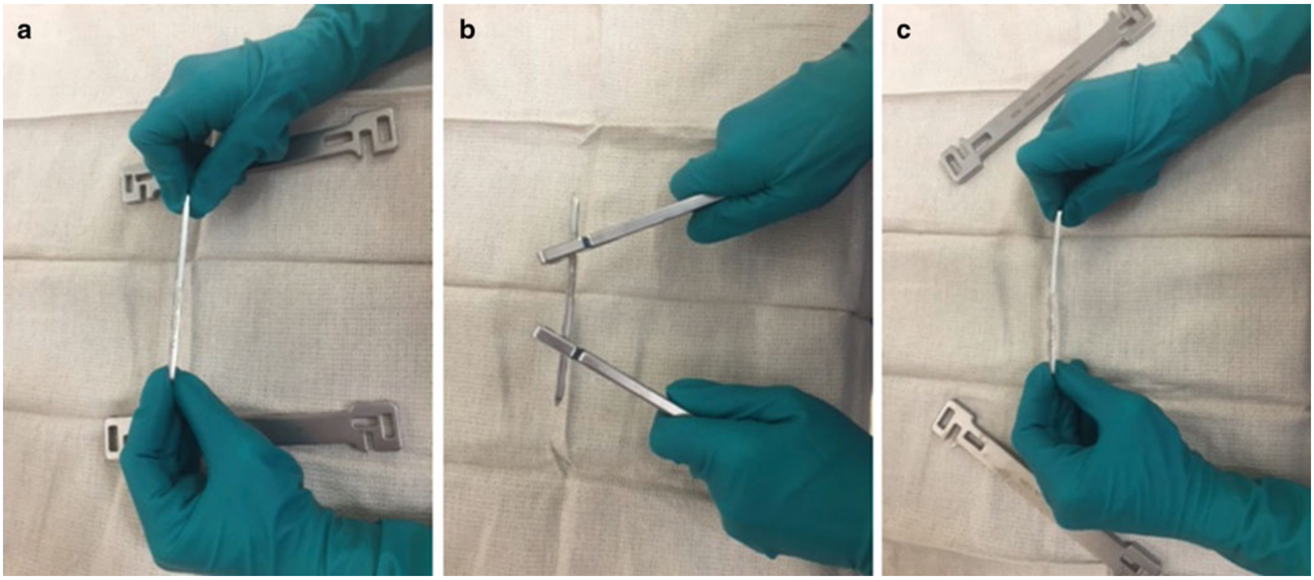


**Fig. 4** Dynamic compression plate (**a**) selected to stabilize the transverse fracture pattern. Technique for precontouring the implant (**b**) with a subtle convex bend at the fracture level (**c**) to ensure the opposite side of the fracture remains compressed during the fixation

## 7 Technical Pearls

1. The operating room is arranged with a radiolucent table and fluoroscopy positioned opposite the surgeons. Consider setting up a separate sterile instrumentation table to use after the debridement in the scenario of open fractures.
2. The open wound should be extended sufficiently to expose and deliver the proximal and distal fractured bone ends for debridement without creating unnecessary additional periosteal stripping.
3. Reduction of the tibia is achieved directly and maintained by clamping the plate to the proximal and distal fractured ends.
4. The plate type and length are selected to allow six cortices of fixation above and below the fracture.
5. If lag screw fixation is unable to be achieved, compression plate technique will achieve absolute stability when direct bone healing is desired.
6. Prebend the plate with a small convex angle at the fracture site (Fig. 4). The plate will straighten as it compresses against the bone forcing the opposite cortex to compress.
7. A neutral bicortical 3.5 mm screw secures the plate to either the proximal or distal segment. Compression is achieved by drilling the next screw eccentrically through one of the plate holes in the opposite bone segment. This maneuver can be performed twice to achieve maximal compression.
8. Alternatively, an external screw-driven compression device can be used to achieve the same compressive effect.
9. Separate fluoroscopic images of the knee and ankle are obtained to exclude associated injury, paying particular attention in skeletally immature patients for physeal widening that may signify a Salter Harris 1 injury of the proximal or distal tibia.
10. The decision to immobilize depends on the axial, angular, and rotational stability of fixation and presence of associated injuries.
11. Progressive weight bearing is initiated when radiographs suggest three of four cortices with bridging bone (average 6–12 weeks), and ankle range of motion and Thera-Band strengthening exercises are performed independently or under the guidance of a physical therapist.
12. Patients are released to unrestricted activity in 3–6 months when strength and mobility return, assuming absence of pain with activities and routine healing on radiographs.

## 8 Outcome Clinical Photos and Radiographs

See Figs. 5 and 6.

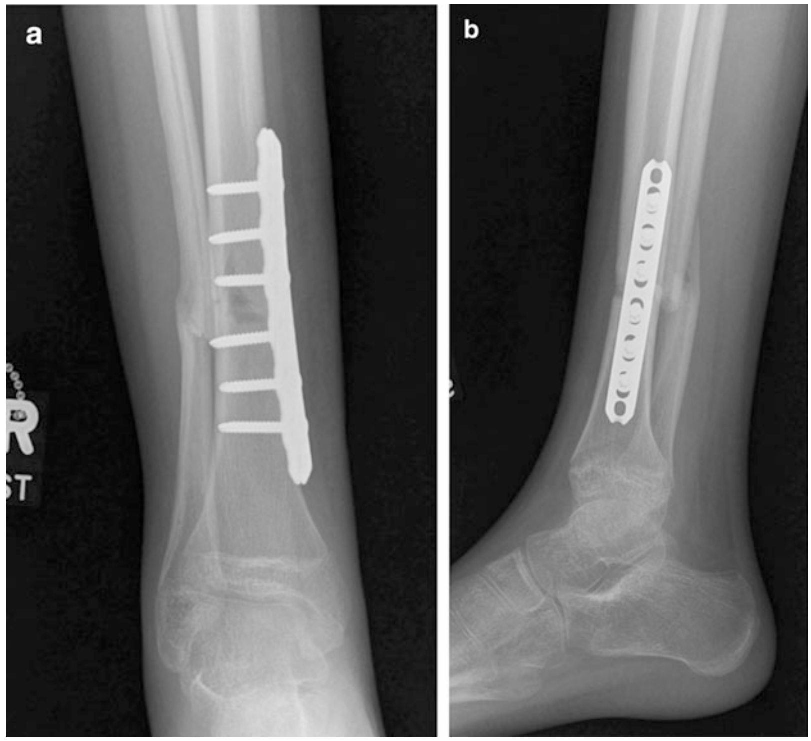


**Fig. 5** Anteroposterior (**a**) and lateral (**b**) radiographs of the right distal tibia 3 months after surgery show bridging bone of at least three cortices and a healed fibula. The patient returned to unrestricted activity 6 months postoperatively

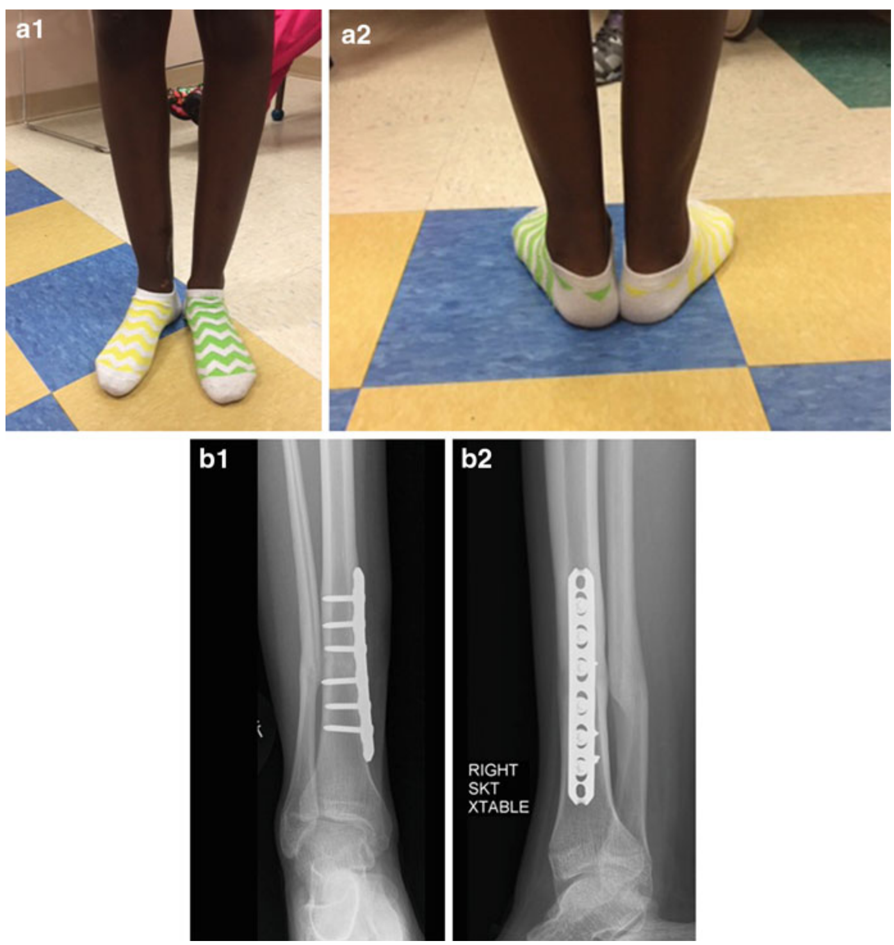


**Fig. 6** Clinical photos (**a**) and radiographic images (**b**) 1 year after surgery showing symmetric lower extremity alignment and remodeling of the tibia. The patient participates in dance without pain or functional difficulties

## 9 Avoiding and Managing Problems

1. A careful preoperative clinical and radiographic examination can avoid missing associated ipsilateral injuries of the extremity, particularly of the ankle.
2. Be prepared with a variety of fixation options in the operating room including internal and external fixation devices.
3. Choose the appropriate plate construct to achieve absolute or relative stability based on the fracture pattern and desired type of bone healing to prevent nonunion and fixation failure.
4. Use indirect reduction techniques and percutaneous plating when possible to preserve the biological healing process.
5. Follow patients at regular intervals to evaluate for loss of alignment, fixation failure, and delay/nonunion that may warrant secondary procedures.

## 10 Cross-References

► Isolated Medial Malleolus Fracture
► Submuscular Plating of Tibial Fractures
► Tibial Shaft Fracture: Flexible Nails
► Tibial Shaft Fracture Treated with a Circular External Fixator

## References and Suggested Reading

Aslani H, Tabrizi A, Sadighi A et al (2013) Treatment of open pediatric tibial fractures by external fixation versus flexible intramedullary nailing: a comparative study. Arch Trauma Res 2:108–112
Head J, Lewis T, Puffinbarger W et al (2014) Plating of open pediatric tibia fractures. J Okla State Med Assoc 107(7):382–383
Masquijo J (2014) Percutaneous plating of distal tibial fractures in children and adolescents. JPO B 23(3):207–2011
Ozkul E, Gem M, Arslan H et al (2016) Minimally invasive plate osteosynthesis in open pediatric tibia fractures. JPO 36(4):416–422
Pandya N, Edmonds E (2012) Immediate intramedullary flexible nailing of open pediatric tibia shaft fractures. JPO 43(8):770–776
Setter K, Palomino K (2006) Pediatric tibia fractures: current concepts. Curr Opin Pediatr 18(1):30–35
Tencer A (2006) Biomechanics of fixation and fractures. In: Bucholz R, Heckman J, Court-Brown C (eds) Rockwood and Green's fractures in adults, 6th edn. Lippincott Williams and Wilkins, Philadelphia, pp 3–41. Print
Yusof N, Oh S, Oh J et al (2009) Percutaneous plating in pediatric tibia fractures. Injury 40:1286–1291