30 Talar Fractures and Fracture Dislocations

Yuneng Li, Liangpeng Lai, and Xinbao Wu

Anatomical Fracture Location: Radiograph of Fracture Pattern

Talar fractures present following high-energy trauma. These injuries account for less than 1% of all fractures of the skeleton. It is not uncommon for patients to present with other associated fractures in the ankle, foot, or in other body regions.

The talus consists of three distinct components: the head, the neck, and the body. The talar neck and the posterior aspect of the body are not covered by cartilage. It is important to appreciate that the blood supply of the talus is unique as three arteries contribute to its vitality: the posterior tibial artery, the dorsalis pedis artery, and the perforating fibular artery [1]. Fracture patterns disrupting the blood supply may lead to avascular necrosis (AVN) and development of post-traumatic osteoarthritis.

Initial clinical assessment should exclude dislocation (requires emergency reduction) and careful evaluation of the neurovascular status of the affected limb. Plain radiography in three projections anteroposterior (AP) and latero-lateral (LL) view and the "mortise view" (AP with 30° internal rotation of the foot) allow satisfactory visualization of the type of injury sustained. CT scan is the choice of investigation in terms of accurate fracture morphology and topography and for preoperative planning.

Talar fractures are divided into head, neck, and body (most common) subcategories. The Sneppen classification for talar body fractures continues to be used in the clinical setting [2]. Morrison classified lateral process fractures into three types (type 1 (simple), type 2 (comminuted), and type 3 (cortical avulsion fracture)) [3]. Subsequently, Hawkins subdivided type 2 into type 2a, <2 mm displacement of fracture fragments, and 2b, >2 mm of displacement [4].

Hawkins-Canale developed the talar neck fracture classification [5]: type 1, nondisplaced talar neck fracture; type 2, talar neck fracture, talocalcaneal dislocation, and tibiotalar dislocation; type 3, talar neck fracture, talocalcaneal dislocation, and tibiotalar dislocation; and type 4, talar neck fracture and disruption of all talar articulations. The incidence of AVN increases as you progress from type 1 to type 4 fracture pattern reaching almost 100% rate.

In peritalar dislocation (hindfoot dislocation), the relationship between talus, navicular bone, and calcaneus has been lost. Noteworthy is that the congruity of subtalar and calcaneocuboid joint remains unaffected. On the other hand, "total dislocation" refers to complete dissociation, and this represents the most serious type of injury. Dislocations should be reduced promptly

Y. Li · L. Lai · X. Wu (✉)
Academic Department of Trauma and Orthopaedic Surgery, Beijing Jishuitan Hospital, Beijing, People's Republic of China

P. V. Giannoudis (ed.), *Fracture Reduction and Fixation Techniques*,
https://doi.org/10.1007/978-3-030-24608-2_30

to facilitate soft tissue resuscitation restoring neurovascular lesions and to allow planning for definitive fixation.

In general terms, simple fractures with less than 2 mm displacement can be managed nonoperatively. When the displacement is more than 2 mm, then reduction and reconstruction are the choices of treatment. Small comminuted, nonviable and non-reconstructable fragments should be excised. Talar body injuries require fixation to restore the anatomy and function of the surrounding joints.

To demonstrate the management of a talar fracture, we present a case study in a male patient 17 years old, who suffered a fall from about 1 m high. On arrival he had right foot pain. Radiographic examination revealed a talar fracture and an associated peritalar dislocation (Fig. 30.1a, b). After routine examinations, he received a closed reduction and plaster immobilization (Fig. 30.2a, b) prior to being transferred to our institution for further management. A CT scan was requested to allow more accurate evaluation of the fracture morphology and topography and demonstrated a peritalar dislocation and fracture of the talar posterior process (Fig. 30.3) (Group D according to Sneppen classification of talar body fracture).

Brief Preoperative Planning

Evaluating the radiographs and the scans (Figs. 30.1–30.3), it can be seen that there are two main displaced posterior fragments (one intra-articular free fragment) involving both ankle and subtalar joints. Consequently, due to the displacement and incongruity of the joint, a

Fig. 30.1 (**a**) AP, (**b**) Lateral radiographs of the right ankle before closed reduction was applied showing the talar fracture/subluxation

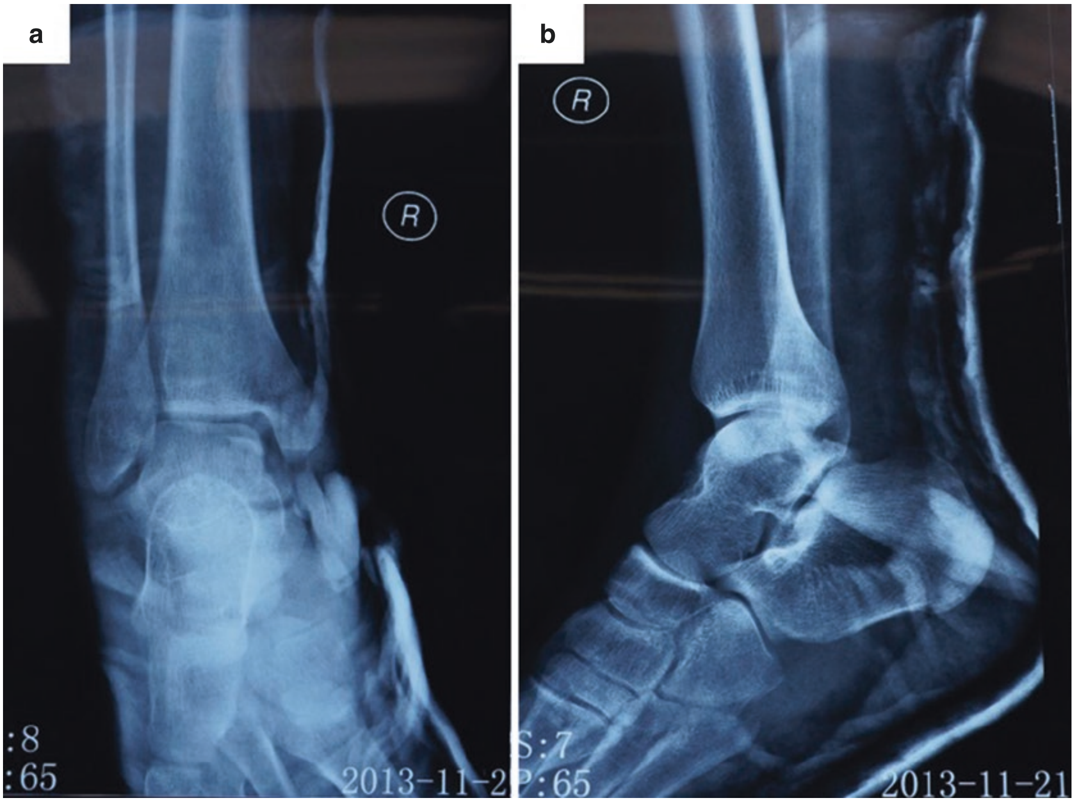


Fig. 30.2 (**a**) AP, (**b**) Lateral radiographs of the right ankle after closed reduction

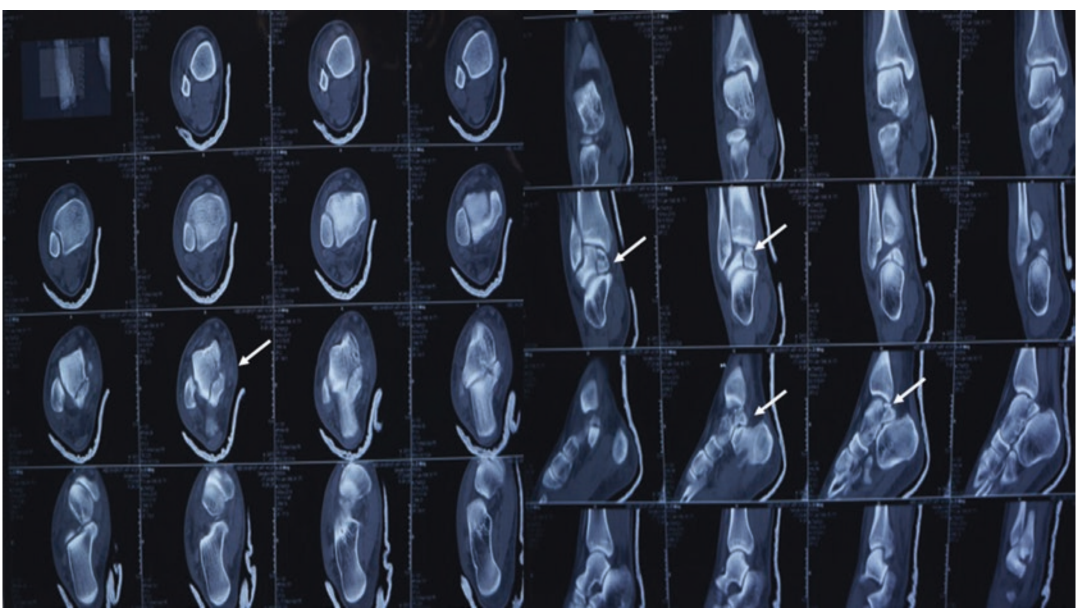


Fig. 30.3 Sections of CT scan in sagittal, coronal, and transverse plane after closed reduction. Arrows show fracture line

decision was taken to proceed with open reduction and internal fixation. As the fracture is located mostly in the posteromedial part of the talus, a single posteromedial approach was chosen for the exposure and reduction.

Patient Setup in Theater

Following epidural anesthesia, the patient was placed in the supine position on a radiolucent operating table with the hip slightly flexed and abducted during surgery. The surgeon was positioned on the left side and the image intensifier on the right to allow easy acquisition of AP/lateral/Canale views. A thigh tourniquet was applied. Prophylactic iv antibiotics were administered at induction.

Closed Reduction Maneuvers

Closed reduction maneuvers are indicated in cases of dislocation or subluxation. Reduction is an emergency procedure. General anesthetic is necessary for optimum muscular relaxation. A technique that can be applied is the one as previously described by Mitchell [6]. Accordingly, the leg with the knee flexed is held by one assistant at a right angle. The surgeon then applies traction by grabbing the heel and forefoot. Using both thumbs, direct pressure is exerted over the protruding lateral prominence to rotate the talus 90° in the anteroposterior plane. Usually, the talus is reduced in the tibiotalar joint with simultaneous reduction of the subtalar and talonavicular joint. Restoration of the normal anatomic contour of the foot is established. Reassessment of the neurovascular status is essential after manipulation. A plaster of Paris can be applied for the maintenance of reduction until definitive reconstruction.

Reduction Instruments

Instruments that can facilitate reduction include reduction forceps, threaded k-wires, Schantz screws, T-handle, Hohmann elevators, periosteum elevator, and ball-spike pusher.

Fig. 30.4 A curved incision about 8 cm was made along the posterior aspect of the medial malleolus following the course of posterior tibial tendon with apex of the curved incision located in the middle of the medial malleolus and Achilles tendon

Fig. 30.5 Careful exposure of the peritendinous layer is shown

Surgical Approach

A curved incision about 8 cm is made along the posterior aspect of the medial malleolus following the course of posterior tibial tendon (Fig. 30.4), with apex of the curved incision located in the middle of the medial malleolus and Achilles tendon.

Carefully expose the peritendinous layer (Fig. 30.5), and dissect the tendon sheath of the flexor digitorum longus (Fig. 30.6). Care should be taken while detaching the posterior tibial artery and tibial nerve. Retract them posteriorly with care (Figs. 30.7 and 30.8).

The same dissection is performed with the tendon of the tibialis posterior, but this was retracted anteriorly over the malleolus (Fig. 30.9). The surgery plane is just between the tendons of

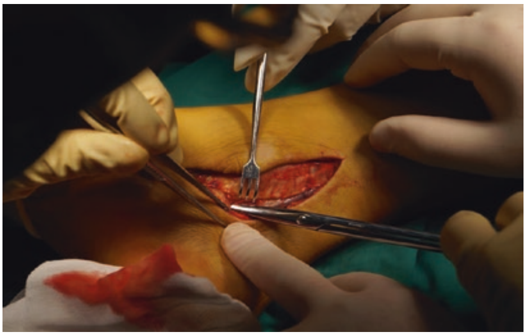


Fig. 30.6 Careful dissection of the tendon sheath of the flexor digitorum longus takes place

Fig. 30.7 Careful dissection and detachment of the posterior tibial artery and tibial nerve

Fig. 30.8 Gently retract neurovascular bundle posteriorly

the flexor digitorum longus and tibialis posterior, which is quite safe with neurovascular bundle protected well by the retraction of the tendons (Fig. 30.10). Subsequently, the posterior capsule is incised if intact.

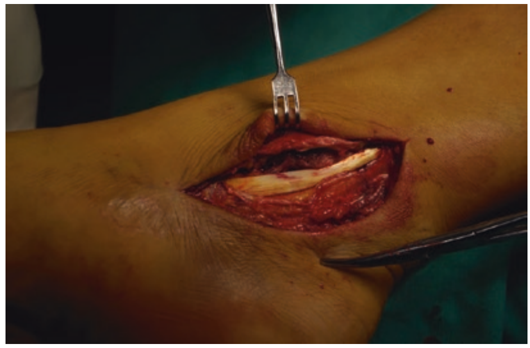


Fig. 30.9 The same dissection took place with the tendon of the tibialis posterior, but this was retracted anteriorly over the malleolus

Fig. 30.10 The surgery plane is just between the tendons of the flexor digitorum longus and tibialis posterior, which is quite safe with neurovascular bundle protected well by the retraction of the tendons

Open Reduction Maneuvers

Soft tissue mobilization and evacuation of the hematoma are necessary to facilitate reduction. Usually we used a calcaneal skeletal traction to conduct axial traction and dorsiflexion at the same time to gain a better operating field. In this case we also used two k-wires pinned respectively into the talar neck and calcaneus to help with better visualization (Fig. 30.11). Opening of the medial bone fragment is necessary to visualize the free fragment in the posterior part of ankle joint. Reduction of the intra-articular piece with elevator under direct vision is then followed (Fig. 30.12), making sure that the articular

Fig. 30.11 Two k-wires pinned, respectively, into the talar neck and calcaneus to help with better visualization of the structures during the exposure

surface is in anatomical position. Figure 30.13 demonstrates the reduction from a direct view (back to front).

Reduction then is carried out for the medial fragment, where a small defect was noticed, which shouldn't affect the reduction and fixation. Using an elevator and artery forceps, the fracture is reduced (Figs. 30.14, 30.15, and 30.16) The two main fracture parts are then secured with two k-wires (Figs. 30.17 and 30.18).

Using the intraoperative image intensifier, the position and direction of the k-wires as well as the fracture reduction can be checked (Fig. 30.19a, b).

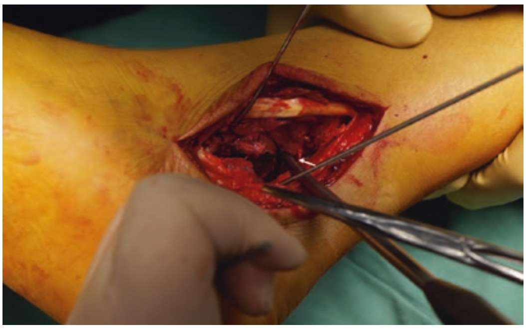


Fig. 30.12 Reduction of the intra-articular piece with elevator (arrow) under direct vision is then followed making sure the articular surface is in anatomical position

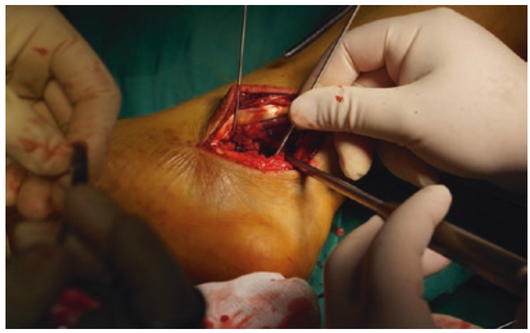


Fig. 30.13 Using the elevator, reduction is done under direct vision back to front

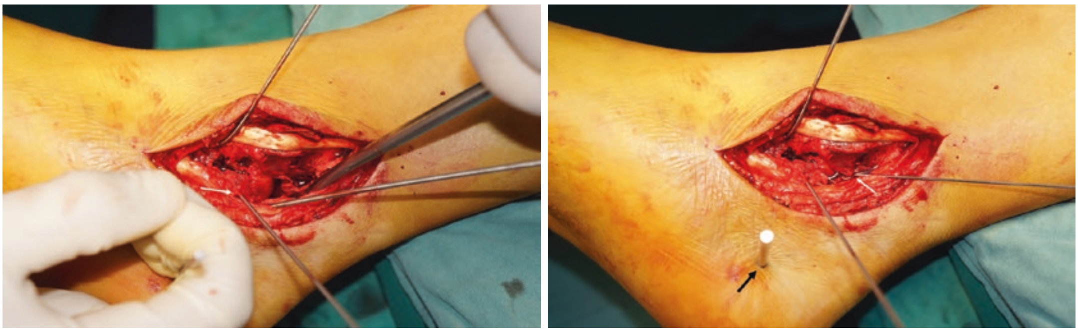
Figs. 30.14 and 30.15 Reduction then is carried out for the medial fragment using an artery clip and the elevator, where a small defect was noticed

Fig. 30.16 The fracture is held in reduction

Since the medial part seemed large enough for two screws, we added another guide pin (Fig. 30.20a–c) with the objective to get a stronger fixation.

Implant Insertion

For the fixation of the fragments, we used the 3.0 mm HCS cannulated screws. Following measurement of the desirable length of the screws and drilling with the cannulated drill,



Figs. 30.17 and 30.18 The two main fracture parts are then secured with two guide wires (white arrows, black arrow points to calcaneal pin inserted to facilitate reduction)

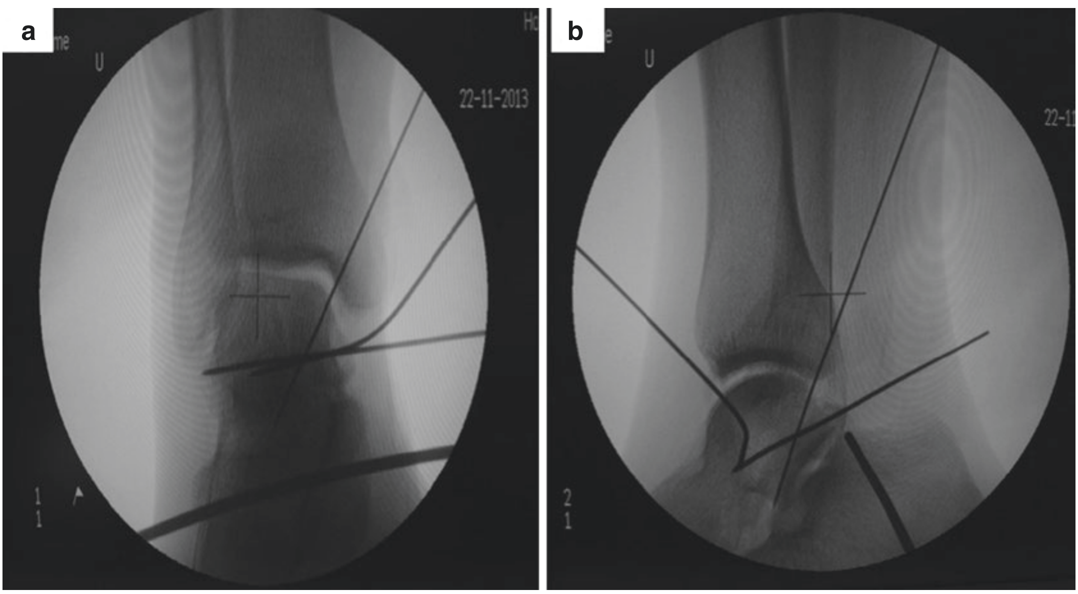


Fig. 30.19 Using the image intensifier, the position and direction of the k-wires as well as the fracture reduction can be checked

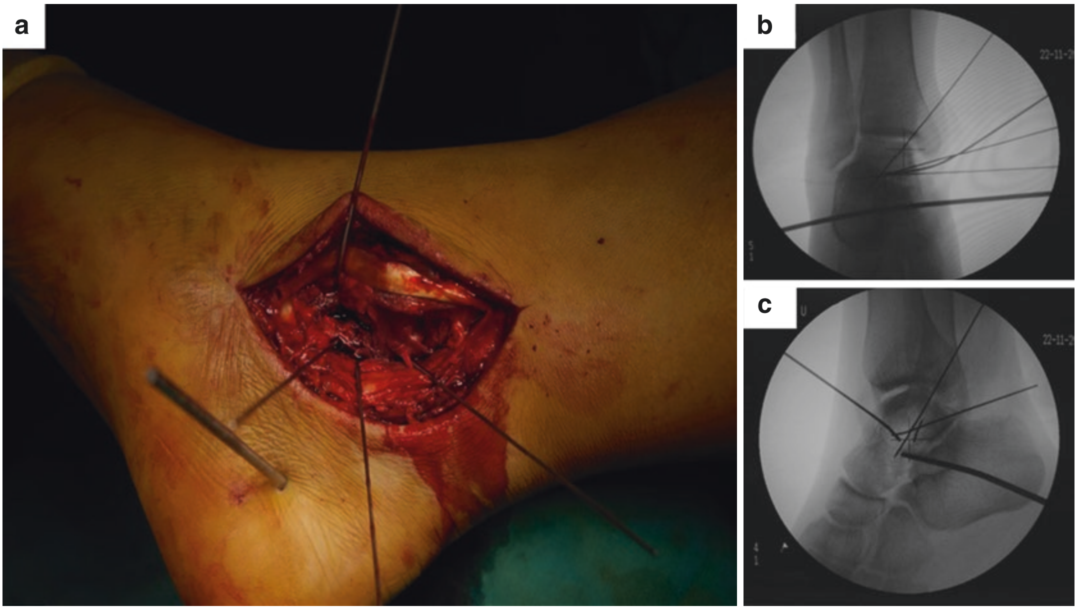


Fig. 30.20 (**a**) Intraoperative picture; (**b**, **c**) fluoroscopic images demonstrating the addition of another k-wire with the objective to get a stronger fixation since the medial part seemed large enough to accommodate two screws

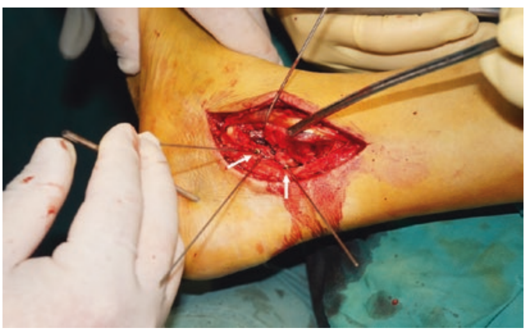


Fig. 30.21 3.0 mm HCS cannulated screws were used for the fixation of the fracture (arrows). The screws were advanced under the articular cartilage surface

the cannulated screws were inserted under the articular cartilage surface (Fig. 30.21). The final screw position and reduction were checked on the image intensifier (Fig. 30.22a, b). The wound then is closed in layers, the tendon sheath is repaired, and dressing and splint applied.

Postoperative instructions include limb elevation, an external boot for support and mobilization non-weight bearing for a period of 8 weeks. Progressive loading of the affected extremity thereafter with the aid of a boot.

Summary of Tips and Tricks-Pitfalls

- The operating field of the posterior tubercle of the talus is relatively limited.
- Violent tractions to widen the window is very dangerous to the vessels and nerve and also to the skin flap.
- Visualization is enhanced if the posterior tibial tendon is retracted anteriorly over the medial malleolus.
- Retracting the neurovascular bundle posteriorly with the tendon of flexor digitorum longus provides better protection.
- Using calcaneal skeletal traction reduction can be aided.

Another case of a male 15-year-old patient who sustained a talar neck/body fracture following a fall with the foot dorsiflexed is presented. Initial radiographs revealed the above injury (Fig. 30.23). He was placed in a splint, and due

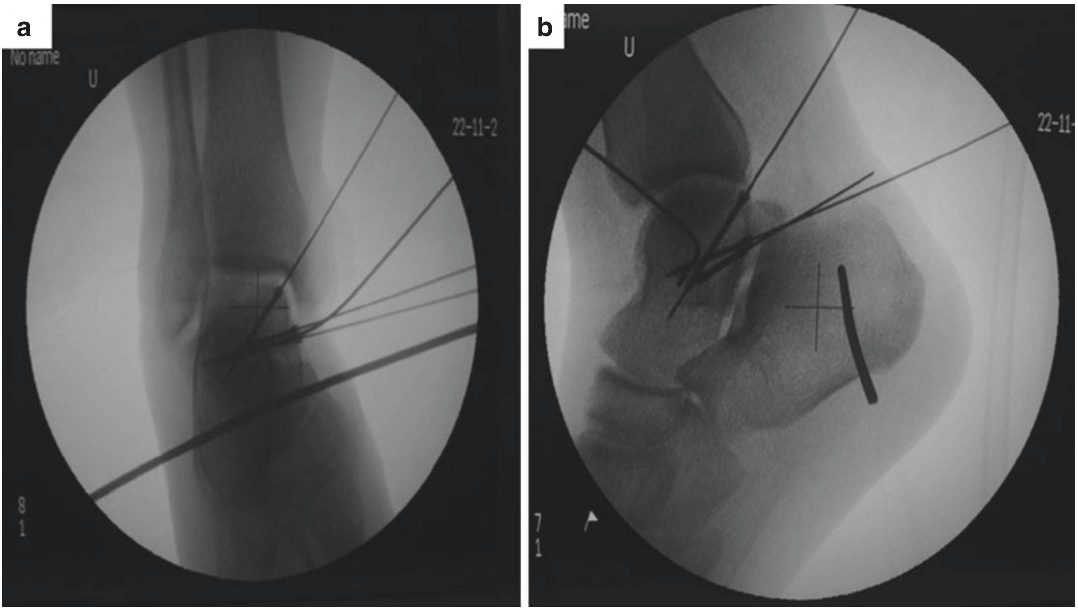


Fig. 30.22 (**a**) AP and (**b**) lateral fluoroscopic views demonstrating final screw position and quality of reduction

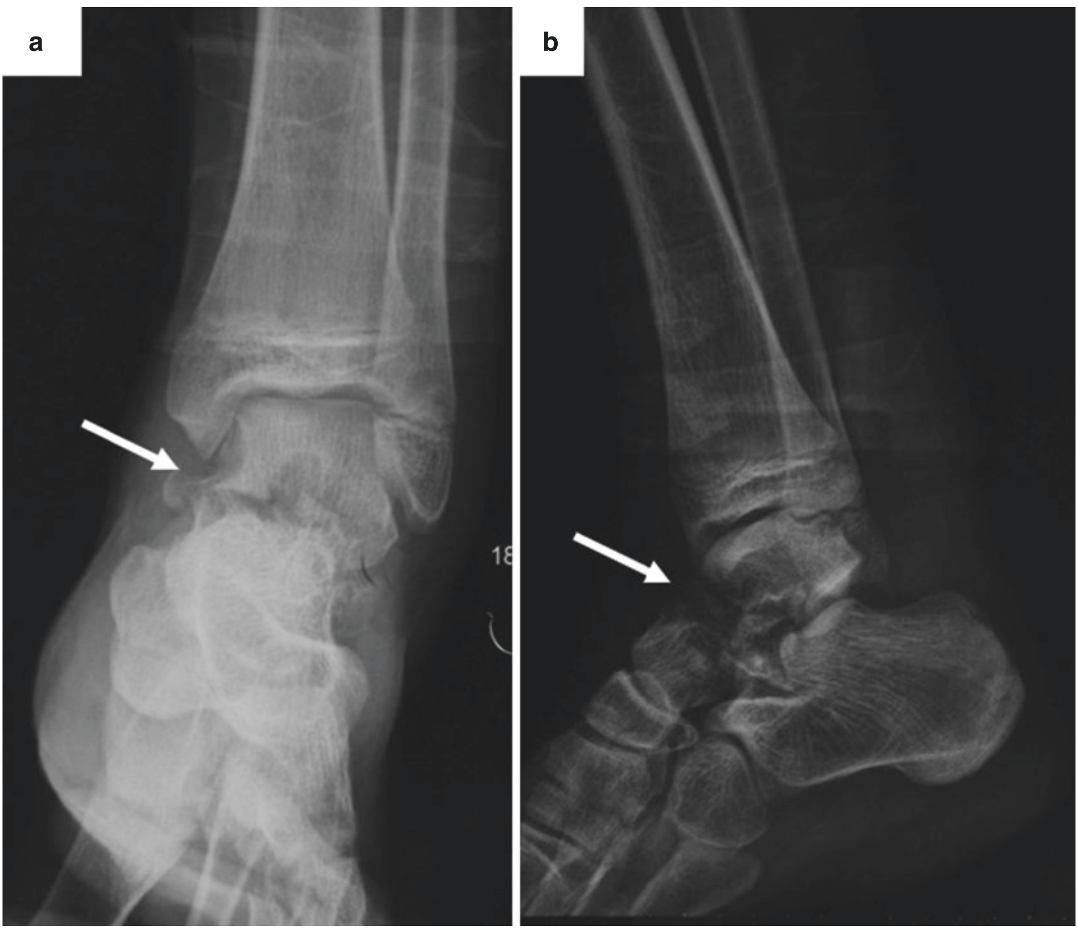


Fig. 30.23 (**a**) AP and (**b**) lateral radiographs showing a talar neck fracture (arrows)

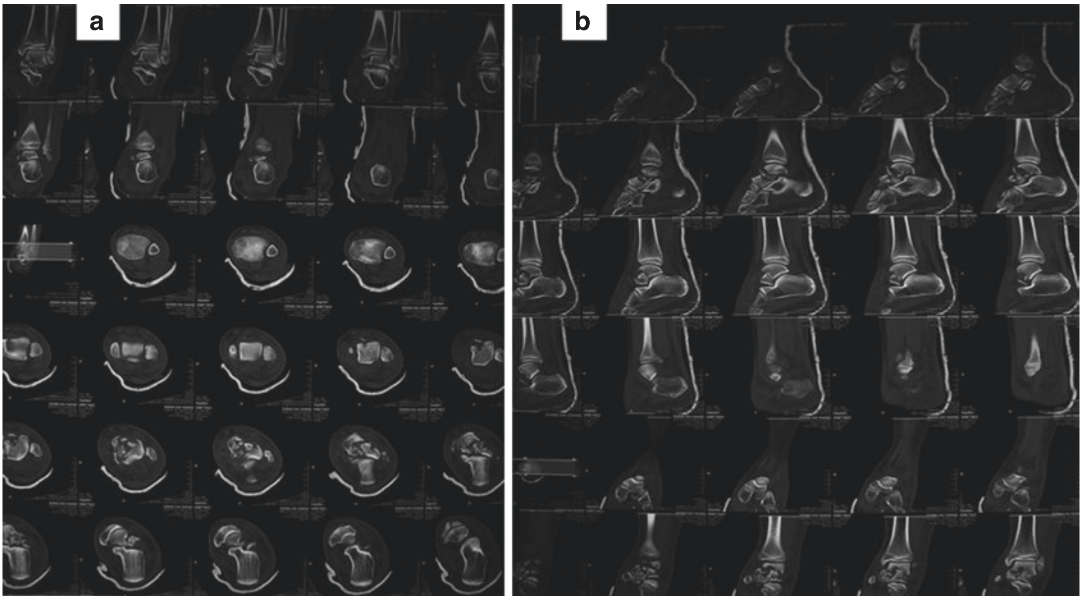


Fig. 30.24 (**a**) Axial and (**b**) sagittal CT cuts showing the fracture morphology and topography

Fig. 30.25 A slice of the 3-D reconstruction of CT scan showing the fracture pattern (arrow)

to soft tissue swelling, he was operated 9 days later. A CT scan obtained as well as a slice of the 3-D reconstruction CT which showed the detailed fracture pattern and fracture topography (Figs. 30.24 and 30.25). It was a type 2 fracture according to the Hawkins classification of talar neck fracture.

Brief Preoperative Planning

As it can be seen by the radiographs and CT scan, the patient had a comminuted talar neck fracture. It is important to restore the length and alignment in this situation. The bone defect and large gap in the neck would probably increase the risk of non-union, so bone grafting at the time of surgery should be considered. Since the talar body fracture was comminuted and relatively small, it was decided to spare it on this occasion. Given that the comminuted neck fracture would cause difficulties for the reduction, it was decided to use two incisions (anteromedial and anterolateral-combined approach) for having a better exposure and reduction. In comminuted fracture patterns, compression is avoided to prevent collapse, and in order to avoid this, small plate was planned to be applied in the anterolateral aspect of the talus-“naked zone.” Subsequently, plaster or brace immobilization should be used.

Patient Setup in Theater

The patient received epidural anesthesia and was placed in a supine position on a radiolucent operating table. A thigh tourniquet is applied, and prophylactic antibiotics were given at induction.

Surgical Approach

An anterolateral incision is made approximately 12 cm in length, which began about 5 cm proximal to the ankle joint, 1 cm anterior to the anterior border of the fibula, then curved down, crossed the ankle joint, and continued until usually the cuboid toward the base of the fourth metatarsal (Fig. 30.26). Care must be taken to preserve the superficial peroneal nerve (Fig. 30.27) by retracting the nerve with the tendons of peroneus tertius and extensor digitorum longus anteriorly and, respectively, retracting the belly of extensor digitorum brevis posteriorly (Fig. 30.28). The anterolateral surgery window lies just between them.

Then the anteromedial incision is made about 8 cm. It begins proximally to the medial malleolus and is curved down to the navicular

Fig. 30.26 Intraoperative picture showing the marked anterolateral skin incision to be made

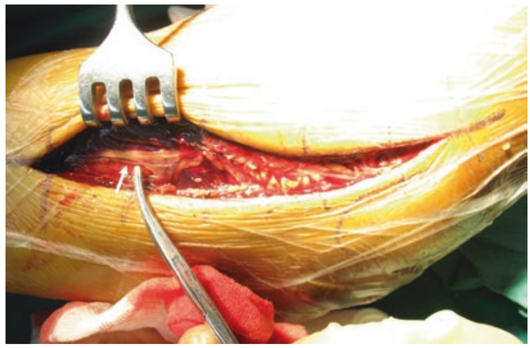


Fig. 30.27 Intraoperative picture demonstrating the superficial peroneal nerve (arrow)

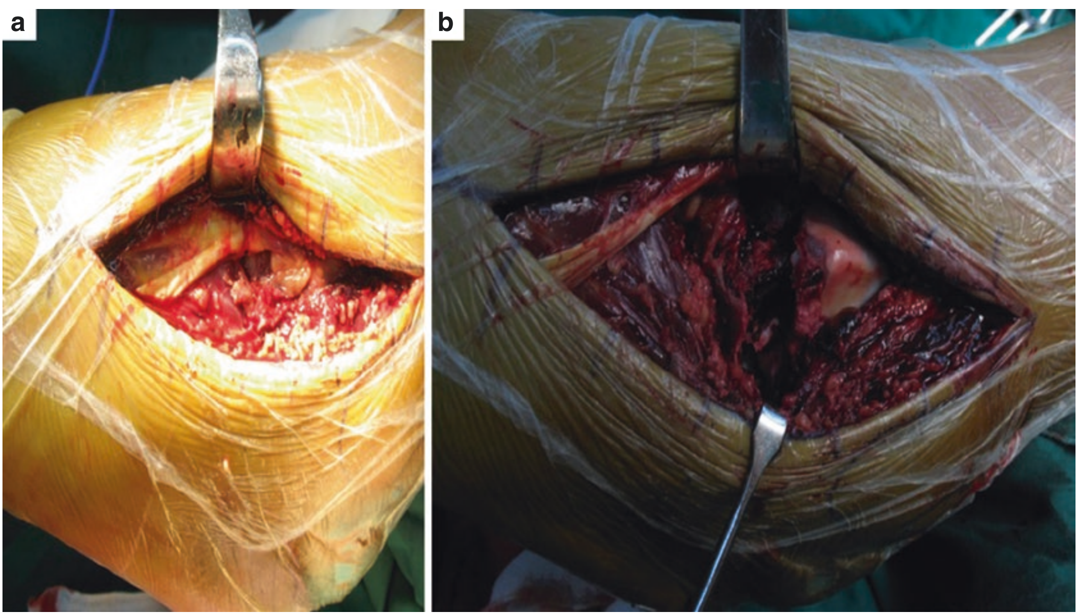


Fig. 30.28 (**a**, **b**) Intraoperative pictures showing the retraction of tendons and visualization of the talar neck fracture

Fig. 30.29 Anterior medial incision (skin marked) between the tendons of tibialis anterior and posterior

Fig. 30.30 Intraoperative picture showing exposure of medial surface of the talar neck

tuberosity. The incision lies just between the tendons of tibialis anterior and posterior, which was easy to palpate and mark (Fig. 30.29). Dissection is continued to the deep fascia to expose the talar neck next to talonavicular joint (Fig. 30.30). Do leave an adequate skin bridge between the two incision to avoid necrosis.

Open Reduction Maneuvers

Following evacuation of the hematoma, the neck was found totally comminuted from lateral to medial, leaving it impossible to judge the reduction under direct vision. Two free osteochondral fragments about 0.5–1.0 cm were retrieved (Fig. 30.31). Fracture is reduced through the two incisions made, allowing anatomic alignment of the two free fragments; then reduction is maintained provisionally with four k-wires: two from the medial wall and two from the lateral. The intraoperative image intensifier was used to confirm the quality of reduction (Fig. 30.32). Check that the positions of subtalar and talonavicular joints look normal.

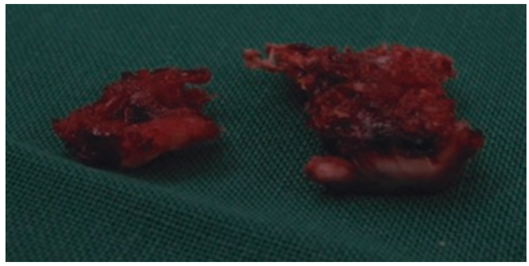


Fig. 30.31 Small osteochondral fragments retrieved

Fig. 30.32 Fluoroscopic images demonstrating a good reduction of the neck from the Canale view

Any abnormality seen in the joints could be an indication that the talar body or head might be rotated or misplaced. From the intraoperative fluoroscopic images, the reduction was found acceptable (length and alignment were both restored, and the subtalar/talonavicular joints were in good position).

Implant Insertion

According to the preoperative plan, a 4 hole 2.0 mm titanium plate was used. The k-wire was removed from the lateral wall, and the plate was contoured to adapt the lateral aspect. Then the plate was fixed with screws, two screws holding the talar head and two screws fixated into the body. The reduction and implant position were checked with image intensifier (Fig. 30.33).

Since the reduction was good, the other three k-wires were replaced with cannulated screws (drilled the hole and placed the screws under the articular cartilage surface). Plate combined with multiple screws should provide enough rigidness for healing. The final reduction and implant position were checked again with the image intensifier (Fig. 30.34a, b).

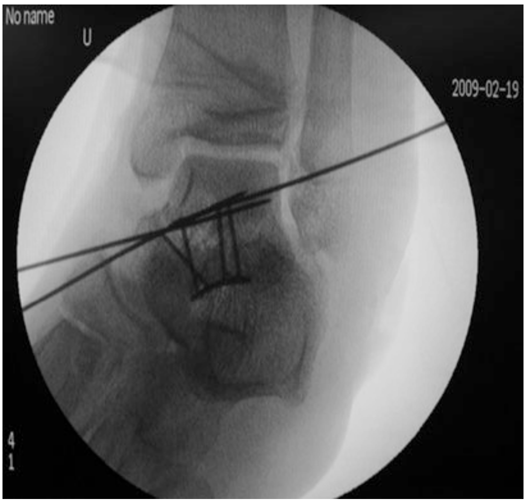


Fig. 30.33 Fluoroscopic images showing plate positioning and fracture reduction

As the patient was very young and the fixation was rigid enough, the defect in the talar neck was found acceptable, so no bone grafting was used here.

The wound was closed in layers, dressing, and splint applied to keep the ankle in neutral position.

Postoperative care includes elevation of the foot, a boot for support and non-weight bearing for at least 8 weeks. After 12 weeks full weight bearing is encouraged with a dedicate rehabilitation program.

Summary of Tips and Tricks-Pitfalls

- The two-incision approach to talar neck fracture should be considered in comminuted fractures.
- The talar neck is a four-sided structure, and once the lateral or/and medial side was/were comminuted, it is hard to judge the reduction from just one side, as what appears to be an anatomic reduction on one side may still

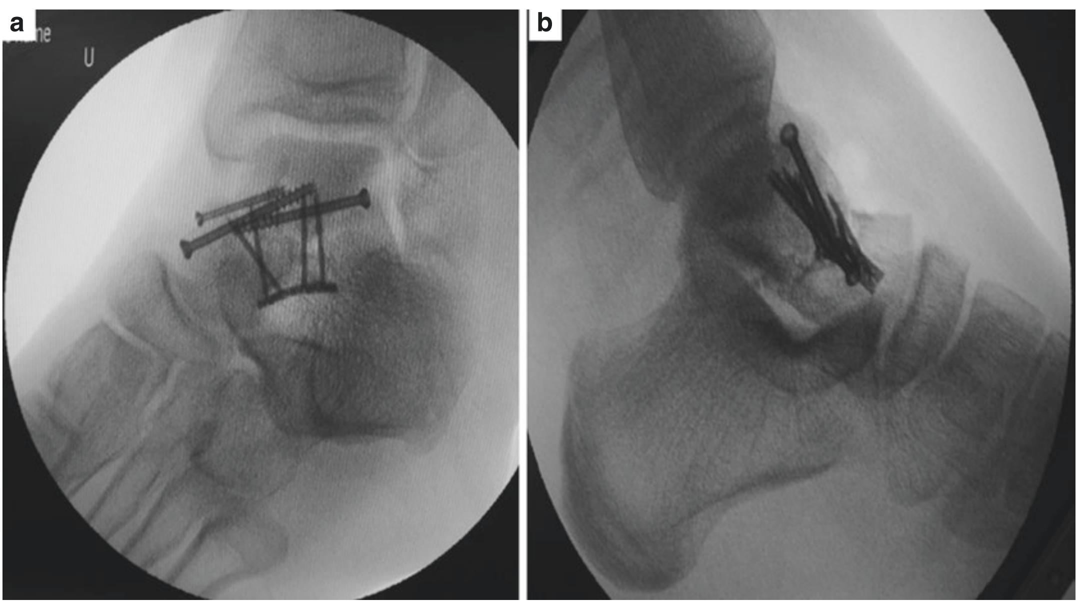


Fig. 30.34 (**a**) AP and (**b**) lateral fluoroscopic views showing final implant positioning and fracture fixation

involve malreduction on the other three surfaces.
- Direct viewing from both directions allows accurate reduction assessment.
- If the neck is severe comminuted, which leaves no anatomic mark (typically the cortical bone) for reduction, the surgeon needs to conduct the reduction by experience. Intraoperative fluoroscopic images would help a lot here. The lateral and Canale views will reveal the restoration of the length and alignment, which are very important to the reduction.
- Theoretically, the plate should be placed on the more comminuted side, typically the medial side. However, the nonarticular zone is very small on the medial side, so most surgeons like to apply the plate on the lateral side. Here, the plate should be contoured very well to suit the surface and not to exert bending pressure to the medial side.
- Talar neck fractures may lead to avascular necrosis of the talus, depending on the type of fracture, typically the Hawkins III and IV talar neck fractures leading to a highly likelihood of AVN. So, avoiding iatrogenic disruption to the blood supply is very important during surgical reconstruction, especially when using a double incision. Care must be taken when dissecting and stripping, especially in the anterolateral approach.

Conflict of Interest No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this chapter.

References

1. Prasarn ML, Miller AN, Dyke JP, Helfet DL, Lorich DG. Arterial anatomy of the talus: a cadaver and gadolinium-enhanced MRI study. Foot Ankle Int. 2010;31(11):987–93.
2. Sneppen O, Christensen SB, Krogsoe O, Lorentzen J. Fracture of the body of the talus. Acta Orthop Scand. 1977;48(3):317–24.
3. Morrison W, Sanders T. Problem solving in musculoskeletal imaging. Philadelphia, PA: Elsevier; 2008.
4. Hawkins LG. Fracture of the lateral process of the talus. J Bone Joint Surg Am. 1965;47:1170–5.
5. Canale ST, Kelly FB Jr. Fractures of the neck of the talus. Long-term evaluation of seventy-one cases. J Bone Joint Surg Am. 1978;60(2):143–56.
6. Mitchell JI. Total dislocation of the astragalus. J Bone Joint Surg Am. 1936;13:212–4.