

Talus fractures

Fraturas do talus

David B. Thordarson*

Abstract

Talar neck fractures are complex, somewhat uncommon injuries which can be difficult to treat with a high risk of complications. Type II fractures with an incongruent subtalar joint can usually be reduced closed and treated with open reduction and internal fixation in a semi-elective fashion. Type III fractures with a dislocated ankle and subtalar joint require urgent operative reduction and fixation to prevent skin necrosis and minimize the risk of avascular necrosis (AVN). The higher the grade of fracture, the higher the risk of complication. Subtalar joint arthritis/arthrosis is the most common complication but AVN is the most devastating complication.

Keywords: Talus/injuries; Bone fractures

Resumo

As fraturas do colo do tálus são lesões complexas, incomuns, difíceis de serem tratadas e apresentam alto risco de complicações. As fraturas do tipo II, com a articulação subtalar incongruente podem, ser de início reduzidas incruentamente e, após tratadas com redução aberta e fixação interna de maneira programada. As fraturas do tipo III, com desvio da articulação subtalar requerem redução e fixação para evitar necrose de pele e minimizar o risco da necrose avascular (AVN). Quanto maior o grau de gravidade, tanto maior será o risco de complicação. A artrite / artrose da subtalar é a complicação mais frequente, porém a mais dramática é a AVN.

Descritores: Tálus/lesões; Fraturas ósseas

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INTRODUCTION

Fractures of the neck of the talus account for approximately 50% of significant injuries to the talus. They are commonly caused by high-energy trauma such as motor vehicle or motorcycle accidents or falls from a height. Although it has been theorized that hyperdorsiflexion of the ankle with abutment of the neck of the talus against the anterior lip of the tibia causes this fracture, it has been found in the laboratory to be caused by axial loading of the ankle in the neutral position while compressing the calcaneus against the overlying talus and tibia.

As talar neck fractures usually result from high-energy trauma, they occur more frequently in young adults. They occur more often in men than women and most frequently in the third decade of life. Many have associated injuries of the musculoskeletal system. Approximately 20% to 30% of patients have associated medial malleolar fractures, especially in Hawkins type III fractures. It is not unusual for patients with severe lower extremity injuries to have an overlooked talus fracture.

Indications/Contraindications

Fractures of the talus are relatively uncommon fractures of the foot, but they have potentially serious complications. Because of the severe disability after nonoperative treatment of a displaced fracture, there are few contraindications for operative treatment of talar neck and body fractures. Since the fracture is usually associated with high-energy trauma, a patient occasionally is too unstable to undergo any operative treatment upon presentation to the hospital. After the patient's condition has stabilized, he or she should be treated in an urgent fashion to minimize the risk of complications, including especially skin necrosis and avascular necrosis of the talar body. Any displaced fracture of the neck or body of the talus requires open reduction and internal fixation. A common treatment goal is urgent anatomic reduction to restore congruity to the ankle and subtalar joints and to reduce the risk of avascular necrosis by preserving the remaining blood supply.

Although these fractures occur relatively infrequently, the consequences may be disastrous, thus, it is important for surgeons who manage patients with acute trauma to be knowledgeable of treatment. This chapter focuses on talar neck fractures but does discuss talar body fractures which require a slightly more extensive intraarticular exposure, usually via a malleolar osteotomy.

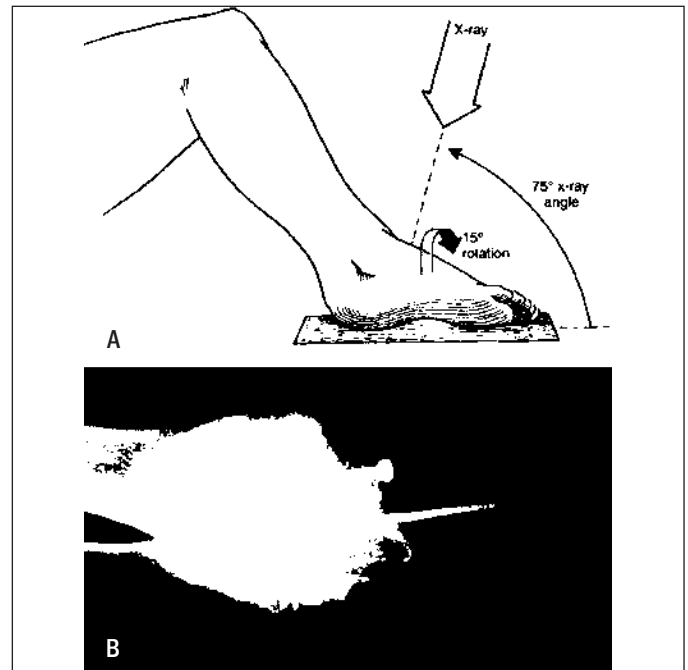


Figure 1 – A and B – A (top) With a cassette placed beneath the foot, the ankle is placed in maximum plantarflexion; the foot is pronated 15°, and the radiograph beam is angled cephalad in a 75° angle relative to the cassette to obtain the modified Canale anteroposterior radiograph of the neck of talus. **B (bottom)** Canale view of the talus was obtained intraoperatively. This view can be useful in demonstrating the adequacy of fracture reduction and fixation placement.

Preoperative preparation

Operative management of these patients should be performed as soon as possible. Physical examination frequently reveals severe swelling of the foot which is usually progressive for the first 24 hours or longer. Fracture displacement can be masked by this swelling, making palpation of fracture dislocations difficult or impossible. The neurovascular structures are generally spared from serious injury. Soft tissue damage can be extensive with a significant incidence of open fractures. Compartment syndrome of the foot sometimes occurs.

Radiographic evaluation includes anteroposterior, lateral, and oblique radiographs of the foot and anteroposterior view of the ankle. These views allow the fracture to be characterized by displacement, comminution, and incongruity of the subtalar, ankle, and/or talonavicular joints. Varus and valgus displacement of the talar neck can be difficult to demonstrate on a routine anteroposterior radiograph. Canale described a modified anteroposterior radiograph (Figure 1) that can be particularly beneficial in the intraoperative assessment of reduction.

Treatment of fractures of the neck of the talus are predicated on their classification.

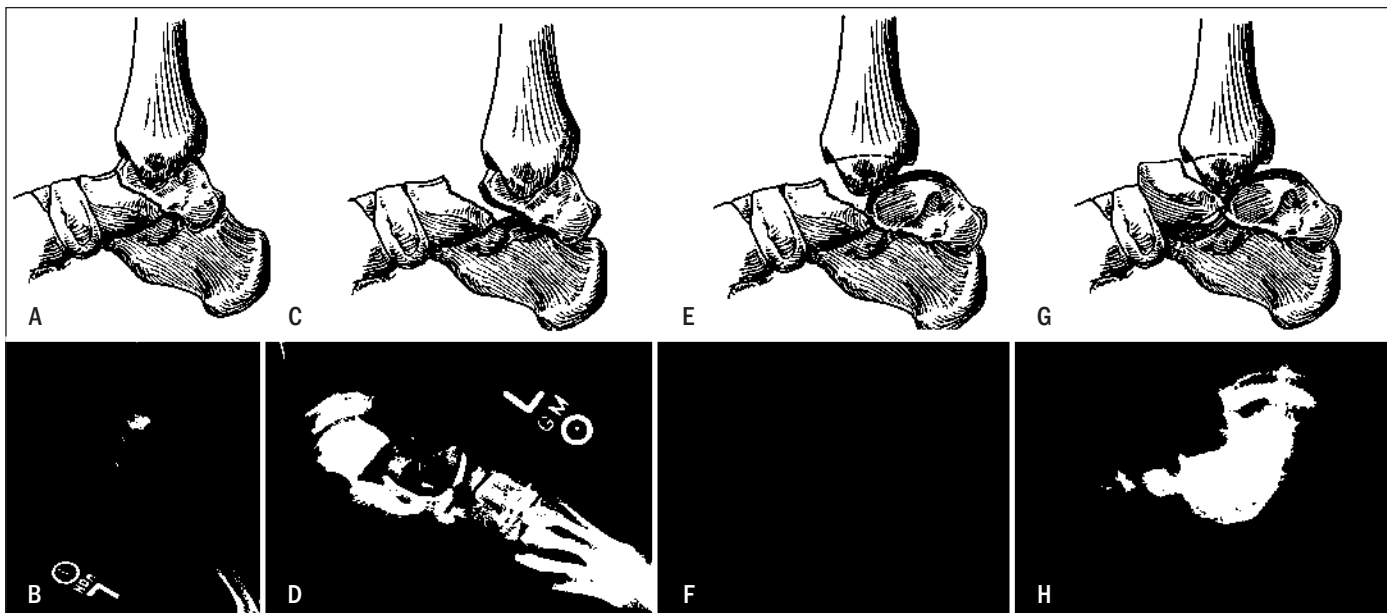


Figure 2 – A – Medial-view diagram of a Hawkins I fracture, which is a nondisplaced fracture of the neck of the talus that has a congruent ankle and subtalar joint. B – Lateral radiograph of Hawkins I fracture. Note the non-displaced vertical fracture of the anterior body of the talus. C – Medial view of a Hawkins II fracture demonstrates displacement of the fracture at the neck of the talus and subluxation of the subtalar joint. Notice that the ankle joint is congruent. D – Lateral radiograph demonstrating Hawkins II fracture with dislocated posterior facet of subtalar joint but congruent ankle joint. E – Medial view of a Hawkins III fracture demonstrates complete dislocation of the body of the talus posteromedially with disruption of the ankle and subtalar joints. F – AP and lateral radiographic views of Hawkins III fracture with dislocation of the body of the talus posteriorly and medially clearly evident here. G – Medial view of the foot shows a Hawkins IV fracture with dislocation of the ankle, subtalar, and talonavicular joints. H – Lateral radiograph demonstrating Hawkins IV fracture with obvious incongruity of talonavicular, ankle and subtalar joint.

Hawkins Classification

Type I

- Vertical fracture at the neck of the talus, nondisplaced with ankle in neutral position (Figure 2-A)
- Fracture disrupts only the blood vessels entering the dorsal and lateral aspects of the neck of the talus and has the minimal rate (0-10%) of avascular necrosis, best overall prognosis
- Treated nonoperatively

Type II

- Talar body fragment is displaced with subtalar joint subluxation or frank dislocation (Figure 2-B)
- Fracture disrupts the blood supply from the dorsal and lateral aspects of talar neck, and the dominant supply from the vascular sling under the neck of the talus
- Worse prognosis, AVN rates of 20-50%

Type III

- Talar body fragment is displaced with subtalar and ankle joint incongruity, body of talus usually dislocated posteromedially between tibia and Achilles tendon. (Figure 2-C)
- Frequently open injuries with approximately 50% rate of fracture of medial malleolus

- Blood supply of talus can be completely disrupted except branches through deltoid ligament
- Urgent reduction may restore blood supply through deltoid branches by removing tension/torsion of these vessels
- AVN rates of 80-100% have been reported

Type IV

- Incongruent ankle, subtalar, and talonavicular joints (Figure 2-D)
 - All possible problems related to Hawkins III fracture with risk of AVN of talar head and talonavicular arthritis
- In patients with fractures of the body of the talus, a preoperative computed tomography (CT) scan in the sagittal and coronal planes can be helpful in defining the fracture anatomy and the degree of comminution. In patients with clearly defined fractures of the talar neck or body based on plain radiography, the CT scan is generally unnecessary and may delay urgent operative treatment of these fractures.

Surgery

The common treatment goal of all fractures of the neck and body of the talus is urgent anatomic reduction with rigid internal fixation. In patients with a Hawkins type II frac-

ture with subluxated or dislocated subtalar joint, an attempt at closed reduction in the emergency room with traction and plantarflexion is warranted. If anatomic or near-anatomic reduction of the fracture is achieved, the patient can be splinted in plantarflexion and taken to surgery in a semi-elective fashion since little remaining tension on the blood supply of the talar body will persist. Open reduction and internal fixation should be performed even if an anatomic closed reduction of a Hawkins II fracture has been achieved, as it avoids the inevitable equinus contracture that develops after a prolonged period of casting in plantarflexion. In Hawkins type III fractures with a dislocated body of the talus, closed reduction is usually unsuccessful and may further traumatize articular cartilage and soft tissue. These cases are surgical emergencies, as the dislocated body of the talus can lead to skin necrosis and disrupts any potential remaining blood supply through the deltoid branches.

Techniques

Fracture without dislocation of the talar body

The patient is placed in a supine position, with a bump under the ipsilateral hip to orient the foot perpendicular to the floor. A thigh tourniquet is used and the leg is prepped and draped about the knee. Figure 3 shows images that are typically obtained with fluoroscopy.

A combined anteromedial and anterolateral approach to the neck of the talus should be used. (Figures 4 and 5) The anteromedial approach is made from the anterior aspect of the medial malleolus to the dorsal aspect of the navicular tuberosity. (Figure 6) The dissection is carried down to the bone, just dorsal to the posterior tibial tendon. Disruption of the deltoid ligament should be avoided as it will violate some of the blood supply to the body of the talus. The fracture can be visualized and subsequently reduced through this incision. Dissection of soft tissues at the level of talar neck dorsally and plantarly should be avoided so such that no further damage to the blood supply occurs.

An anterolateral hindfoot incision is made that allows for exposure of the lateral aspect of the talar neck to confirm the accuracy of reduction and to provide another site for hardware placement. (Figures 8 and 9) Because of limited exposure medially, the fracture may be malreduced with only an anteromedial incision. The second incision also permits removal of any osteochondral fragments from the subtalar joint. Fracture comminution is frequently present on the medial neck of the talus, thus visualizing the lateral aspect of the talar neck can provide a more accurate assessment of the adequacy of reduction since there is less frequently laterally based comminution.

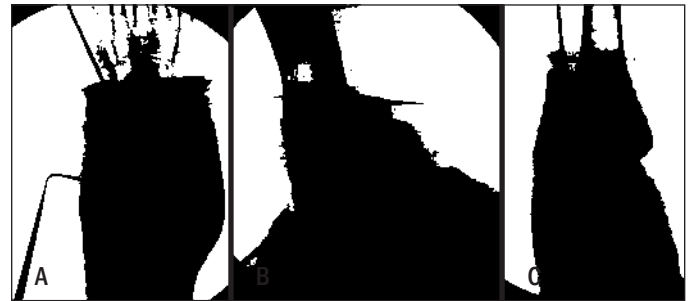


Figure 3 – Intraoperative fluoroscopic views of the foot and ankle in patient with a displaced type II fracture during fixation. A: Anteroposterior view of the foot. B: Lateral view of the foot. C: Anteroposterior view of the ankle.

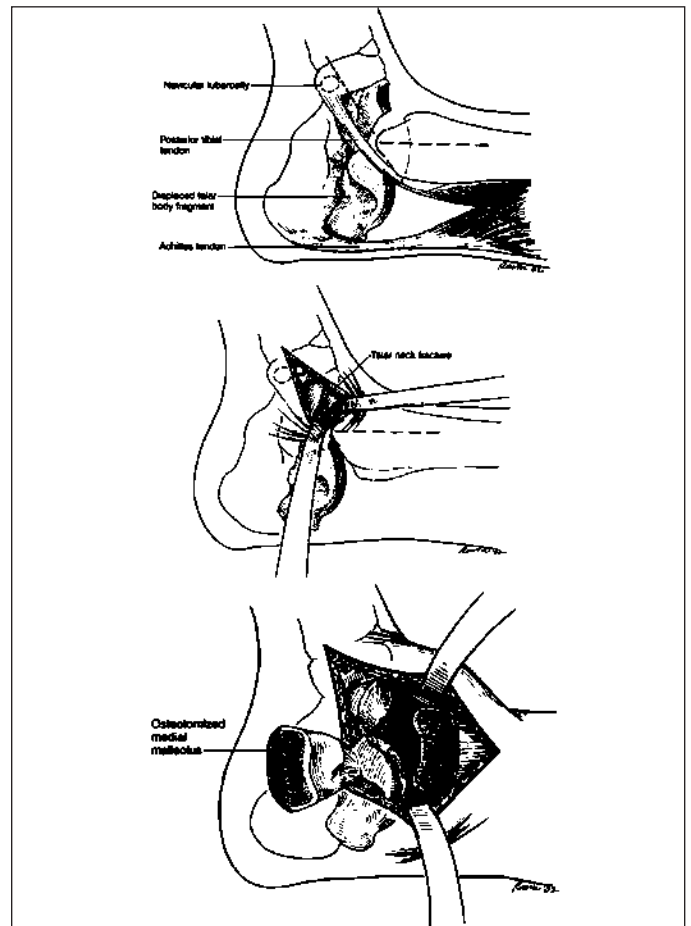


Figure 4 – Anterior-medial approach to the talus.

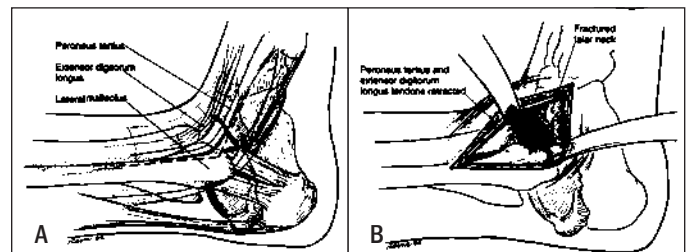


Figure 5 – Anterior-lateral approach to the talus.



Figure 6 - Intraoperative photograph demonstrating the location of the medial incision. The toes are oriented to the left and the incision is marked just dorsal to the navicular tuberosity (vertically oriented crescent shape) and the anterior aspect of the medial malleolus.



Figure 9 - Intraoperative photograph demonstrating reduction through lateral incision after placement of provisional K wire.

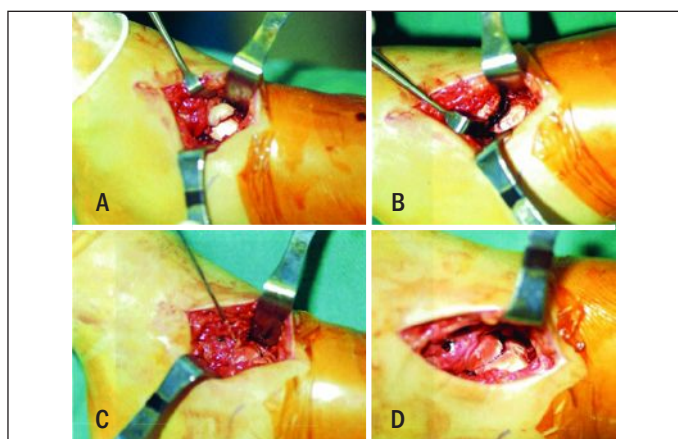


Figure 7 - A: Intraoperative photograph demonstrates the appearance of a displaced talar neck and body fracture through the medial approach. Notice the dissection spares the region of the deltoid ligament, which carries some of the remaining blood supply to the body of the talus. B: Intraoperative photograph demonstrates the appearance of the fracture after it has been distracted, allowing for debridement of the hematoma and osseous debris. C: Medial intraoperative photograph demonstrates a Kirschner wire and screw across the reduced talar neck. D: Medial photograph after placement of a cortical screw through the distal medial aspect of the talar neck.



Figure 8 - Intraoperative photograph demonstrating location of lateral incision (crescent mark over the tip of the fibula).

The anterolateral hindfoot incision is made from the anterior aspect of the lateral malleolus toward the base of the fourth metatarsal. The extensor digitorum longus and peroneus tertius tendons are retracted. The extensor digitorum brevis muscle is retracted dorsally. If osseous fragments are evident in the subtalar joint preoperatively, they should be located and removed, possibly with the aid of a lamina spreader in the sinus tarsi. The subtalar joint can be probed blindly and irrigated to remove any articular debris that may not have been evident on preoperative radiographs.

The fracture is reduced under direct visualization through the medial and lateral incisions. The surgeon must beware of comminution of the medial neck of the talus because it can lead to a varus malreduction of the neck of the talus that subsequently leads to a rigid, supinated foot. The fracture may have a gap on the lateral neck if the medial side has been provisionally fixed in a shortened manner. The provisional reduction should be stabilized with 0.062 inch Kirschner wires. After provisional pin stabilization, the clinical alignment of the foot should be assessed to confirm there is no tendency toward varus or supination of the forefoot. Subsequently, intraoperative lateral foot, anteroposterior foot, and Canale fluoroscopic views should be obtained to assess the quality of reduction. (Figure 10)

Once the reduction has been deemed adequate, definitive fixation should be placed. In general, fully threaded titanium small fragment screws may be used. Since medial comminution is frequently present, lag screw fixation is often not used as it may redisplace the fracture into varus due to compression of this compromised bone. A minimum of two screws should be placed across the fracture site. A hard cortical ridge of bone is usually present along the dorsal aspect of the sinus tarsi that allows for excellent fixation with one or two screws inserted from the lateral neck of the talus across the fracture site. Titanium implants allow for postoperative magnetic resonance imaging (MRI) of the

talus with minimal artifact to assess for the presence of avascular necrosis, when necessary. Stainless steel screws may also be used but they significantly disrupt MR images and thus are not used routinely by the author. Some examples of screw placement are shown in figure 11A and 11B.

If the fracture is located in the distal neck of the talus, the head of the screw can be countersunk into the head of the talus. (Figure 12A and B) In significantly comminuted fractures, a contoured plate can be placed along the sinus

tarsi with transverse screws across the neck of the talus and anterior to posterior screws into the body of the talus. (Figure 13) Although placement of the screws through a posterolateral approach from the posterior tuberosity of the talus into the head has been shown to provide better biomechanical stability, it is a more difficult approach, and fracture reduction still needs to be performed under direct visualization through the anteromedial and anterolateral approaches. (Figures 14 and 15)

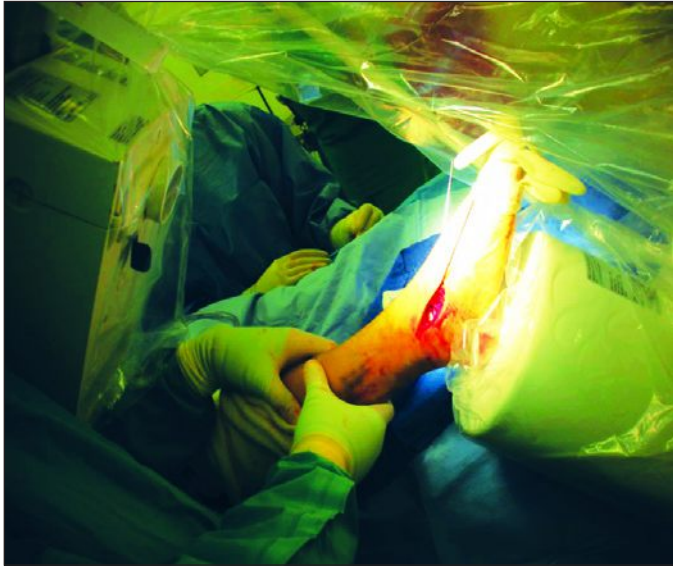


Figure 10 - Intraoperative photograph demonstrating foot sitting on mini-fluoroscopy unit after placement of provisional fixation.

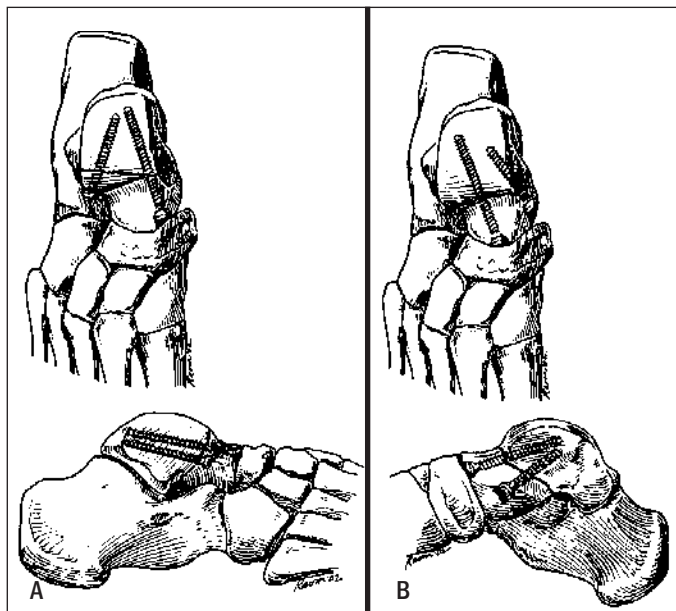


Figure 11 - A - Example of screw fixation placement for a displaced talar neck fracture, with screws entering dorsally and laterally. B - Example of screw fixation placement for a displaced talar neck fracture, with screws entering dorsally and dorsomedially.



Figure 12 - A and B - A: Lateral preoperative radiograph of a patient with a Hawkins II fracture demonstrates subluxation of the talar dome fragment. B: Postoperative radiograph of the same patient after open reduction and internal fixation with two fully threaded cortical screws inserted from anterior to posterior.



Figure 13 - AP radiograph demonstrating medial small fragment screw and lateral contoured mini-fragment titanium plate used to fix Hawkins III fracture dislocation. There was not an adequate bridge of bone to place lateral screw across neck in this case.

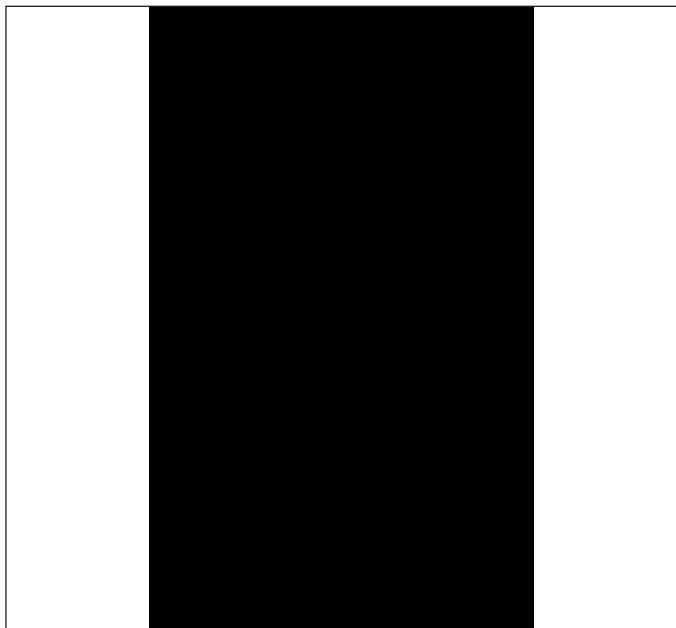


Figure 14 - This non-compliant patient had broken anterior to posterior small fragment screws; therefore, 2 posterior to anterior 6.5 mm screws were placed to provide stronger fixation.

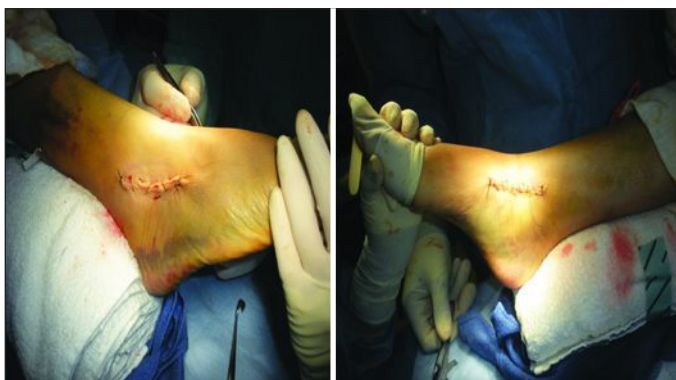


Figure 15 - Postoperative appearance (left picture-A) of lateral and medial wounds closed without tension.

Fracture with Hawkins III dislocated talar body

In Hawkins type III fractures in which the body of the talus is dislocated posteromedially, the medial approach must be extended over the medial malleolus and the distal aspect of the tibia. (Fig. 16A) The body of the talus is identified in the subcutaneous tissue between the posterior aspect of the tibia and the Achilles tendon. (Fig.16B) If the medial malleolus is fractured, it is retracted distally to facilitate reduction of the body of the talus back into the mortise. (Figure 16) Despite the excellent exposure of the talar body with this approach, reduction is usually very difficult. A large, smooth Steinmann pin can be placed transversely in the posterior-inferior aspect of the calcaneus to act as an intraoperative traction device. A femoral distractor may be

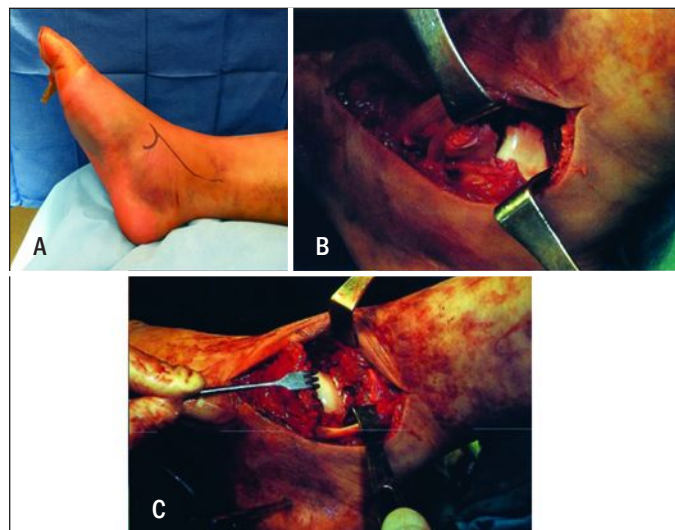


Figure 16 - A - Intraoperative photograph demonstrating location of incision from navicular tuberosity which is curved proximally to overlie distal medial tibia. B - Intraoperative photograph through a medial incision after dissecting through the subcutaneous tissues. The severely displaced dorsal articular surface of the talus is visible through the subcutaneous tissues. The posterior tibial and flexor digitorum longus tendons are retracted anteriorly. Notice the proximal extension of the incision over the distal medial aspect of the tibia to facilitate exposure of the dislocated body of the talus. C - Intraoperative photograph through a medial incision after the medial malleolar fracture is retracted distally and the body of the talus is reduced into the mortise. Notice the large, smooth traction pin in the posterior aspect of the calcaneus that facilitates reduction of the talar body.

used, with pins in the calcaneus and tibia. (Figure 17) With vigorous traction applied and direct manual pressure over the body of the talus, reduction of the talar body back into the mortise can be achieved with some difficulty. If a patient has an intact medial malleolus, the traction pin is still placed to reduce the body of the talus through the interval between the malleolus and posterior tibial tendon. If it is still not possible to reduce the body of the talus, a medial malleolar osteotomy should be performed. In addition, in the case of a talar body fracture through the central portion of the talus, a malleolar osteotomy will likewise be necessary to assess fracture reduction.

Although an oblique malleolar osteotomy can be performed quickly, a step-cut osteotomy allows for a larger cancellous bone surface and can be easily reduced with good initial stability at the conclusion of the procedure. The osteotomy is performed by first identifying the level of the ankle joint anteriorly and posteriorly. Before making the osteotomy, two parallel drill holes are made in the medial malleolus for osteotomy reduction and fixation at the end of the procedure. (Figure 18A) The anterior ankle capsule from the axilla of the ankle joint to the anterior aspect of the deltoid ligament is released. The superficial and deep pos-

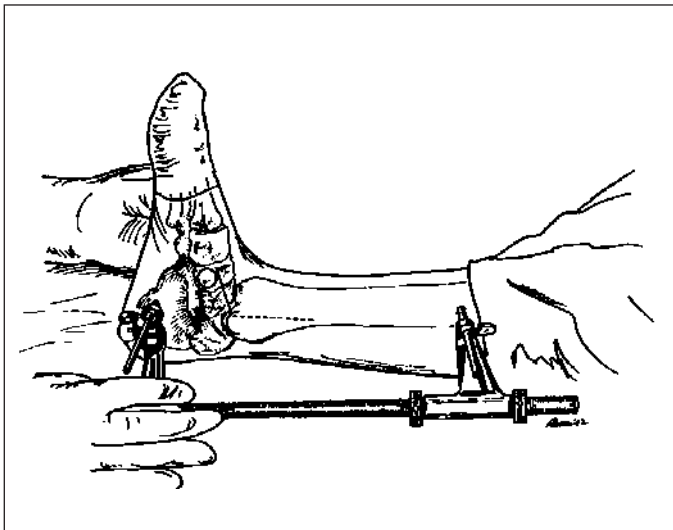


Figure 17 - The femoral distractor is applied for traction to facilitate difficult fracture reduction with a pin in calcaneus and in tibia.

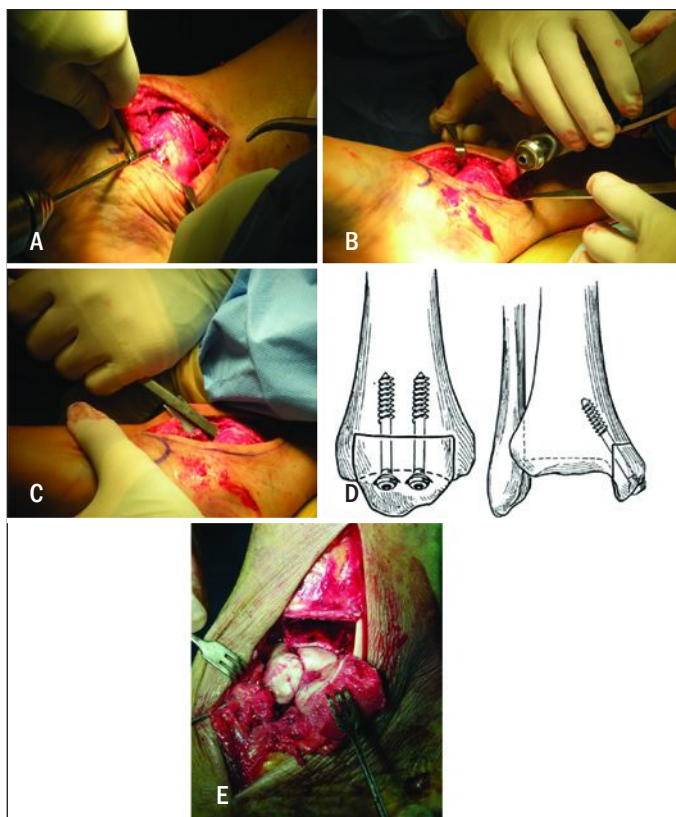


Figure 18 - A - Intraoperative photograph showing the pre-drilling of the medial malleolus prior to performing the osteotomy. B - Intraoperative photograph demonstrating saw cutting transversely into tibia approximately 5mm above the level of the plafond. C - Intraoperative photograph demonstrating narrow osteotome completing step-cut osteotomy from anterior to posterior. D - Schematic diagram of step-cut osteotomy of medial malleolus. E - Intraoperative photograph demonstrating malleolar fragment retracted inferiorly. Note excellent visualization of the talar dome fracture which has been reduced and held provisionally with a K wire.

terior tibial tendon sheath is released from the level of the osteotomy to the posterior aspect of the medial malleolus. A retractor is placed to protect the posterior tibial tendon when performing the osteotomy. The periosteum is incised approximately 5 to 10 mm superior to the ankle joint, and a narrow, oscillating saw bladed is used to cut transversely through the tibia to the level of the medial axilla of the ankle joint. (Figure 18B) The vertical portion of the osteotomy is then made from anterior to posterior with a narrow, straight osteotome. (Figure 18C) A diagram of the osteotomy is presented in (Figure 18D). The medial malleolus is reflected distally, taking care not to damage the deltoid ligament. (Figure 18E) To properly mobilize the medial malleolar fragment, the anterior joint capsule and the posterior tibial tendon sheath must be released as described previously.

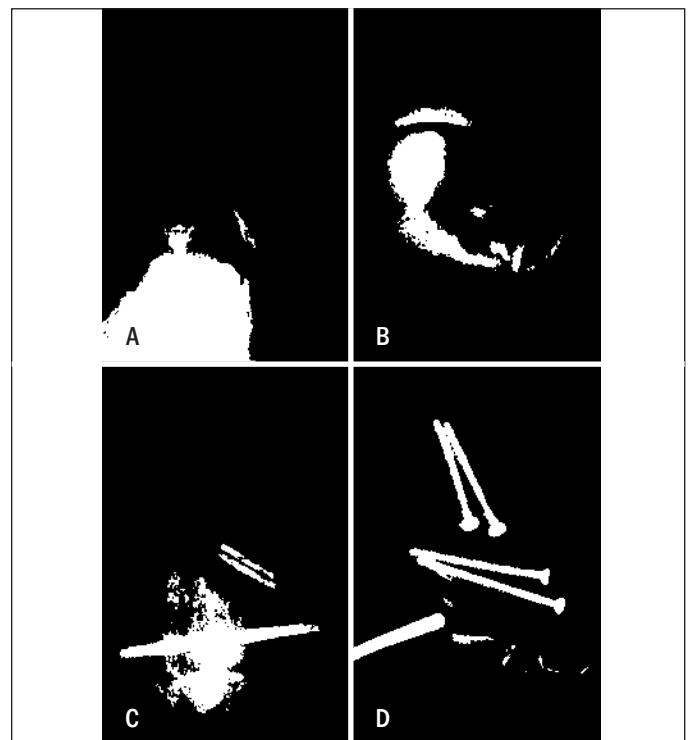


Figure 19 - A: preoperative anteroposterior radiograph of the ankle after a Hawkins III fracture. Notice the body of the talus is dislocated medially and rotated approximately 90° on its deltoid ligament attached to the fractured medial malleolus. B: Preoperative lateral radiograph demonstrates posteromedial dislocation of the body of the talus. The medial malleolar fragment is visible as a crescent-shaped density anterior to the ankle joint. Notice the congruent talonavicular joint. C: Intraoperative anteroposterior radiograph after open reduction and internal fixation of the talar neck and medial malleolar fractures shows the large, smooth Steinmann pin that was placed for traction. D: Intraoperative lateral radiograph demonstrates congruent reduction of the ankle and subtalar joint with a large, smooth Steinmann traction pin still in place. Notice the fully threaded cortical screws used for neutralization fixation of the talar neck fracture and partially threaded cancellous screws for fixation of the medial malleolar fracture.

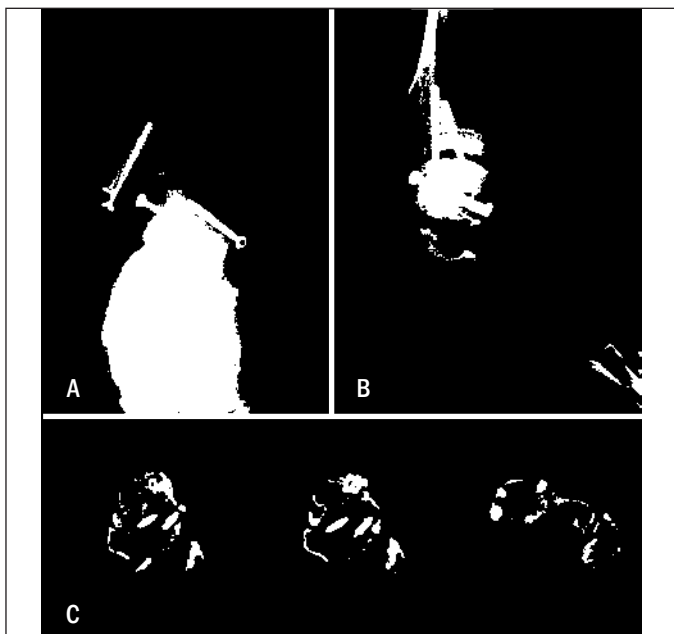


Figure 20 – A and B - A. AP radiograph following open reduction internal fixation with medial malleolar osteotomy. B (right x-ray) Lateral radiograph demonstrating probable healed talar body fracture. C - Representative transverse CT cuts demonstrating screws with obliteration of fracture lines through body of talus.

After the body of the talus has been reduced, an anterolateral incision is made to facilitate exposure of the fracture or subtalar joint, if necessary. A medial malleolar osteotomy allows visualization of the entire dorsal aspect of the talar dome. After reducing and fixing the fracture of the talus, the medial malleolar fracture or osteotomy is fixed with two partially threaded, 4.0 mm, cancellous, titanium screws. (Figure 19) The skin incisions are closed in standard fashion.

Pearls and Pitfalls

- Use two incisions to expose the talar neck to ensure anatomic reduction while minimizing dissecting around the neck of the talus which can further devascularize the talar body
- Beware medial talar neck comminution as it can make anatomic reduction difficult; if it is not reduced it will lead to a stiff, varus, supinated foot
- Use titanium fixation in the event that postoperative MR imaging is desired
- In general, use non-compression fixation, i.e., fully threaded screws or a plate, to avoid compressing through comminuted bone
- With difficult fracture patterns, be prepared to contour a small plate along the lateral neck and body of the talus for fixation
- Reduction of a dislocated Hawkins III talar body is always difficult

- In Hawkins III fractures with an intact medial malleolus or displaced central talar body fracture, be prepared to perform a medial malleolar osteotomy

Postoperative management

A posterior splint with ankle in neutral position is applied. After the incisions have healed, approximately 2 to 3 weeks after surgery, the sutures are removed and a splint or boot is applied. At this time, a patient can begin ankle and subtalar range of motion exercises, provided that rigid internal fixation was achieved at the time of surgery. Range of motion exercises are not advised until wound healing has occurred. Patients should be kept on a non-weight bearing program for approximately 8 to 12 weeks after surgery, until there is radiographic evidence of union such as trabeculae crossing the fracture. In a case of a questionable union, a CT scan can be helpful to confirm fracture healing. (Figure 20)

RESULTS AND COMPLICATIONS

Ideally, the patient should be able to perform activities of daily living without significant pain. Because of the severe soft tissue injury, most patients have some subtalar and ankle stiffness and are limited in performing high-impact activities to some degree in the long term. Due to the severe nature of the injury, patients should be counseled that it is unlikely the foot will return to its normal condition.

Complications after fractures of the neck and body of the talus include avascular necrosis, subtalar and ankle joint arthritis and arthrofibrosis, skin necrosis, osteomyelitis, nonunion, and malunion. Avascular necrosis of the body of the talus after a fracture of the neck can occur in patients after Hawkins I, II, III, and IV fractures. The diagnosis has classically been made on plain radiographic evaluation. The Hawkins sign, a subchondral radiolucency, is an active process and therefore rules out the presence of avascular necrosis. (Figure 21) It should be evaluated on an anteroposterior radiograph of the ankle without a cast 6 to 8 weeks after injury. Absence of the Hawkins sign, however, does not always indicate avascular necrosis. Magnetic resonance (MR) scans can reliably demonstrate avascular necrosis and the volume of necrotic bone. (Figure 22) Sometimes a CT scan can be helpful, also. (Figure 23)

The long-term prognosis of patients with avascular necrosis is uncertain. Some authors state it takes 2 years for the talus to revascularize completely. Others state that the development of avascular necrosis does not guarantee a poor result. However, collapse of the dome of the talus generally leads to a poor result. Because of the risk of collapse, some surgeons have recommended prolonged periods without



Figure 21 – Anteroposterior radiograph of a patient demonstrating avascular necrosis of the lateral half of the body of the talus. Notice the subchondral radiolucency (i.e., Hawkins sign) in the medial half of the body of the talus. The sclerotic lateral portion of the body of the talus has evidence of the avascular necrosis.

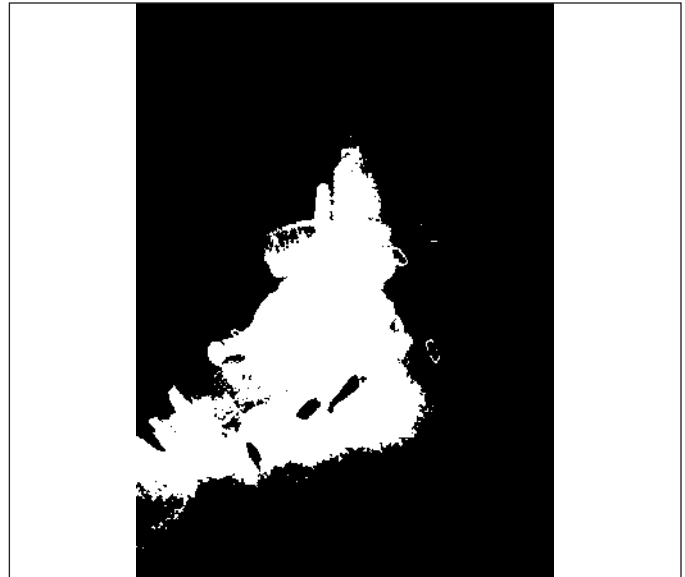


Figure 24 – Postoperative lateral radiograph of a patient after a split-thickness skin graft for full-thickness skin slough after delayed treatment of a Hawkins III fracture. The skin necrosis occurred directly above the dislocated body of the talus. Staples outline the margin of the skin graft.



Figure 22 – Coronal MR scan of a patient with avascular necrosis of the body of the talus. Notice the minimal scattering about the titanium screws, evident in the distal medial aspect of the tibia, that had been placed across the medial malleolar fracture. Notice the decreased signal in the avascular portion of the dorsal body of the talus.

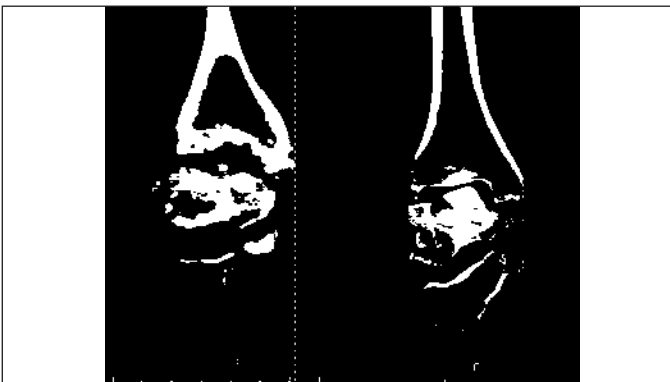


Figure 23 - CT representative coronal CT scan of patient with AVN of talus. Note the sclerotic and fragmented bone in the dorsomedial talus.

weight bearing after these injuries. One report described a patient who experienced segmental collapse 2.5 years after injury upon commencing weight bearing. The current protocol for weight bearing after operative treatment of talar neck fractures without avascular necrosis includes weight bearing as tolerated after fracture healing. The author's personal practice in patients with avascular necrosis involving more than one third of the talar body is to advise them of the risk of late segmental collapse after weight bearing. They are offered a patellar tendon bearing brace or prolonged use of crutches during the period of revascularization. However, most patients choose to begin weight bearing after the fracture is healed.

All patients who sustain a fracture of the neck of the talus are at risk for developing arthrofibrosis or arthritis of the subtalar and ankle joints. Subtalar joint stiffness/ arthritis has been shown to be the most common complication following talar neck fracture. More than half of all patients in most larger series have developed some degree of degenerative changes. Severely decreased range of motion of the ankle and/or subtalar joints is associated with a poor result. Although some degree of stiffness of these joints can be expected, early and aggressive range of motion exercises after wound healing can help to limit stiffness. Because of chondral injury at the time of fracture, arthritis of the ankle and subtalar joints can occur in the absence of the avascular necrosis of the body of the talus or without joint incongruity.

Malunion of a talar neck fracture is usually a preventable complication with proper operative technique. It results in incongruity and degenerative arthritis of the ankle and subtalar joints. Varus malalignment is most common because of the frequent comminution that occurs along the medial neck of the talus. More severe deformity is associated with more severe stiffness and is difficult to treat even with a salvage operation such as an arthrodesis.

Nonunion may occur but is uncommon after a talar neck fracture. Patients with avascular necrosis of the body of

the talus may have fracture union between the viable neck and avascular body. Delayed union is more common than nonunion, occurring in approximately 10% of patients.

Skin necrosis can occur after delayed treatment of a Hawkins III fracture with a dislocated body of the talus or following an open fracture. (Figure 24) When present, these wounds require aggressive debridement and early soft tissue coverage. Delayed treatment of these wounds can lead to deep infection that is difficult to eradicate and generally requires additional surgeries and leads to a more protracted recovery.

BIBLIOGRAPHY

Alexander JJ, Watson JT. Step-cut osteotomy of the medial malleolus for exposure of the medial ankle joint space. *Foot Ankle Int.* 1991; 11(4):242-3.

Canale ST, Kelley FB Jr. Fractures of the neck of the talus. *J Bone Joint Surg Am.* 1978; 60(2):143-56.

Hawkins LG. Fractures of the neck of the talus. *J Bone Joint Surg Am.* 1970; 52(5):991-1002

Lindvall E, Haidukewych G, DiPasquale T, Herscovici D Jr., Sanders R. Open reduction and stable fixation of isolated, displaced fractures. *J Bone Joint Surg Am.* 2004; 86(10):2229-34.

Penny JN, Davis LA. Fractures and fracture dislocations of the neck of the talus. *J Trauma.* 1980; 20(12):1029-37.

Peterson L, Goldie I, Lindell D. The arterial supply of the talus. *Acta Orthop Scand.* 1974; 45(2):260-70.

Thordarson DB, Triffon M, Terk M. Magnetic resonance imaging to detect avascular necrosis after open reduction and internal fixation of talar neck fractures. *Foot Ankle Int.* 1996; 17(12):742-7.

Vallier HA, Nork SE, Benirschke SK, Sangeorzan BJ. Surgical treatment of talar body fractures. *J Bone Joint Surg Am.* 2004; 86 Suppl 1(Pt2):180-92.