Management of Talar Body Fractures

Abstract

Fractures of talar body are uncommon injuries often associated with fractures of other long bones and in polytraumatized patients. The integrity of the talus is essential for the normal function of the ankle, subtalar, and midtarsal joints. The relative infrequency of this injury limits the number of studies available to guide treatment. They occur as a result of high-velocity trauma and are therefore associated with considerable soft tissue damage. Axial compression with supination or pronation is the common mechanism of injury. Great care is necessary for diagnosing and treating these injuries. Clinically, talar body fractures present with soft tissue swelling, hematoma, deformity, and restriction of motion. Associated neurovascular injury of the foot should be carefully examined. The initial evaluation should be done with foot, and ankle radiographs and computed tomography is often done to analyze the extent of the fracture, displacement, intraarticular extension, comminution, and associated fractures. Differentiating talar neck from body fractures is important. Optimal treatment relies on an accurate understanding of the injury and the goals of treatment are the restoration of articular surface and axial alignment. Indications for nonoperative management are seldom indicated and are few as in nonambulatory patients, or in with multiple comorbidities who are not able to tolerate surgery. Splinting, followed by short leg casting for 6 weeks until fracture union should be undertaken. Surgery is indicated in most of the cases, and different approaches have been described. Sometimes, a dual approach with a malleolar osteotomy is necessary for articular restoration. Clinical outcomes depend on the severity of the initial injury and the quality of reduction and internal fixation. The various complications are avascular necrosis, malunion, infections, late osteoarthritis, and ankylosis of subtalar joint.

Keywords: *Talus, talar body, talus complications, talus management, fractures*
MeSH terms: *Talus; talar body; fracture; subtalar joint; arthroscopy; arthritis; malunion*

S R Sundararajan, Abdul Azeem Badurudeen, R Ramakanth, Shanmuganathan Rajasekaran[1]

Department of Foot and Ankle Surgery, Arthroscopy, [1]Department of Orthopaedics, Ganga Hospital, Coimbatore, Tamil Nadu, India

Introduction

Fractures of talar body are rare and serious injuries, frequently seen as an associated injury in long bone fractures and in polytraumatized patients. The high variability of talar fractures and their relatively low incidence together with the high percentage of concomitant injuries makes treatment of these injuries a challenge to the surgeon. They constitute <1% of all fractures and 13%–23% of talus fractures.[1,2] These fractures are seen following high-velocity injuries and are therefore associated with considerable soft tissue damage. In addition fractures of the talar body are difficult to identify adequately due to the overhang of the tibial plafond anteriorly and posteriorly and are often missed.[3]

Anatomy

The talus is second largest tarsal bone. Talus is unique bone because of its two important aspects. First, its blood supply is retrograde and second, 70%–80% of it is covered by articular cartilage. Talus can be subdivided into the head and neck, and body. The head articulates with the navicular bone anteriorly. The neck is the narrow region between head and body. The cervical and the interosseous talocalcaneal ligaments occupy the sinus tarsi. The talar body is roughly cuboidal in shape and has the lateral and posterior process. The trochlear surface on the dorsal side articulates with the distal end of the tibia. The lateral surface is triangular, smooth, and vertical concave for articulation with lateral malleolus while the medial surface is covered by comma-shaped facet for articulation with medial malleolus.

Blood Supply of Body of Talus

The artery of the tarsal canal constitutes the single major arterial supply to the body of the talus. It supplies the middle one-half to two-thirds of the body directly [Figure 1]. These vessels are well-protected extraosseous, lying within the superior

Address for correspondence:
Dr. S R Sundararajan,
Ganga Medical Centre and Hospitals Pvt Ltd,
Department of Foot and Ankle Surgery, Arthroscopy,
313, Mettupalayam Road,
Coimbatore - 641 043,
Tamil Nadu, India.
E-mail: sundarbone70@hotmail.com

portion of the tarsal canal, and is reinforced by external anastomoses with the anterior tibial and peroneal systems. It is likely that minimally displaced fractures of the talar neck do not interrupt the major contribution of this vessel to the body of the talus.

There is other two significant minor blood supply to the body of the talus. One is the deltoid branches of the posterior tibial artery which supplies the medial one-third of the body, and these vessels constitute the most significant minor blood supply to the body. Another significant minor arterial source is provided by the branches of the artery of the sinus tarsi which directly enters the lateral one-eighth to one-half of the body. Two less significant sources were the superior neck vessels from the anterior tibial artery and the posterior tubercle branches of the posterior tibial and peroneal arteries.[4]

Mechanism of Injury

One possible mechanism of injury leading to fracture of the body of the talus is a fall from a height, producing an axial compression of the talus between the tibial plafond and the calcaneum.[3] Sneppen *et al.* described that only certain nonphysical forces, for example, pronounced caudal compression, force during pronation and especially supination trauma will injure the body of the talus. They found that medial side talar body fractures, is typical of supination trauma (compression or shear type), whereas a lateral side fracture is due to pronation or pronation-external rotation trauma (compression fracture).[5]

Classification of Talar Body Fractures

It is important to differentiate talar body fractures from the neck of talus fracture due to the difference in management and the prognosis. Talar body fractures are identified by the fracture line that extends within or posterior to the lateral

process of the talus. Inokuchi *et al.* distinguished talar neck and body fractures by inspecting the fracture line on the inferior surface. They described talar body fracture like the one in which the fracture line on the inferior surface extends into the subtalar joint.[5]

Talar body fractures have various classifications, and these classifications does not help in making treatment choices or predict outcome.[6] The commonly used Sneppen's classification divided these fractures into five types[7] [Figure 2], and Fortin classified them into three types[8] [Table 1].

In addition to these classifications, fractures of the talar dome can also be further classified into sagittal, coronal, transverse, or segmental fractures.[7] Boyd and Knight have classified talar body fractures according to the plane of the fracture line. A Type I fracture is a shear injury in the coronal or sagittal plane, compared to the Type II fracture which involves the horizontal plane. Fall from a height with resultant axial loading appears to be the most common mechanism of injury resulting in a shearing-type talar body fracture.[3]

Clinical Evaluation

Fractures of the talar neck and body are clinically evident with swelling and hematoma over the ankle [Figure 3]. The

Table 1: Classification of talar body fractures

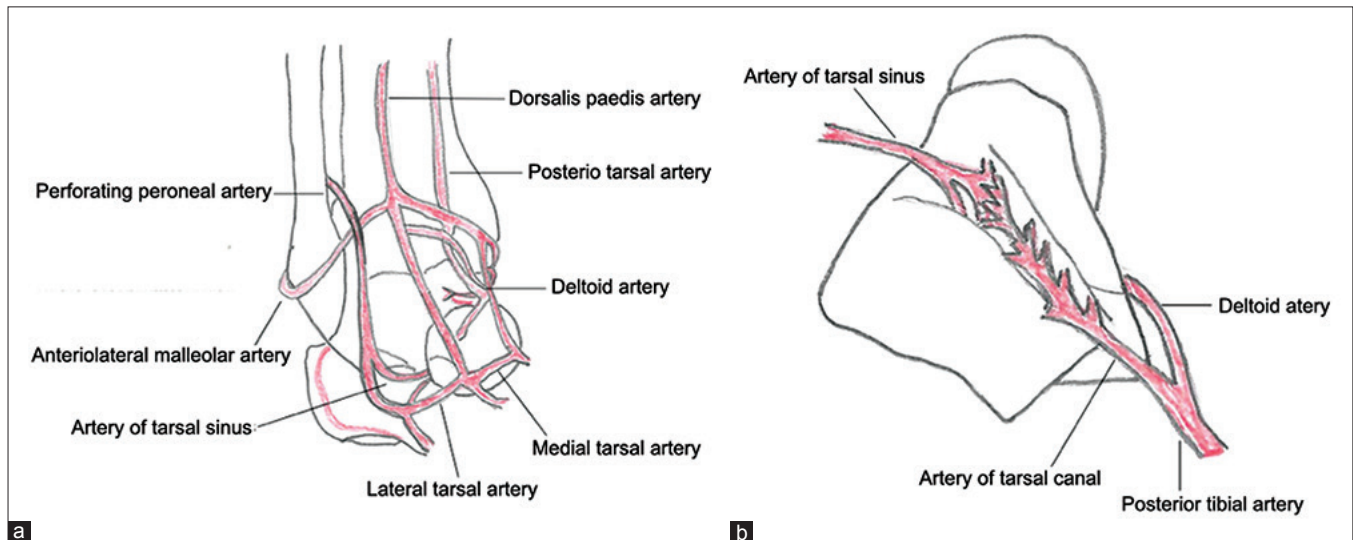| Sneppens classification		Fortin's classification	
Type	**Fracture pattern**	**Type**	**Fracture pattern**
1	Transchondral or osteochondral	1	Fracture of talar body on any plane
2	Coronal, sagittal horizontal, nonsegmental	2	Fracture of the talar process or tubercle
3	Fractures of posterior tubercle	3	Compression and impaction fracture of the talar body
4	Lateral process fracture		
5	Crush injuries		

Figure 1: A line diagram showing blood supply of Talus. (a) Anteroposterior view, (b) Inferosuperior view
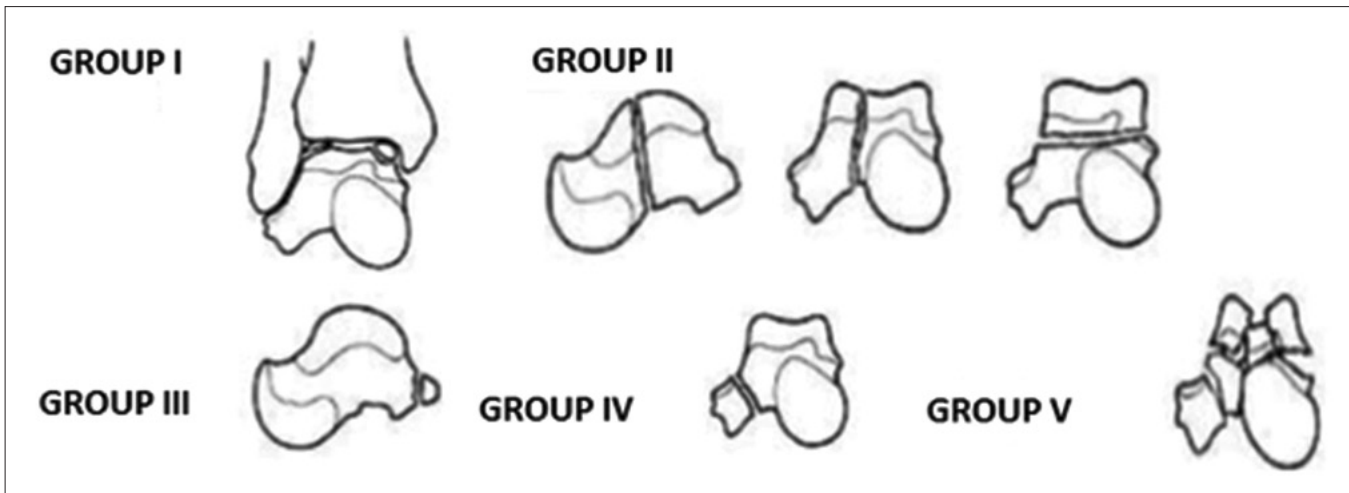
Figure 2: A line diagram showing Sneppens classification of talar body fractures

Figure 3: Clinical photographs showing variation in presentation (a) Deep abrasion on anterolateral aspect of ankle (b) Internal degloving of skin (c) Large lacerated wound on anterolateral aspect ankle

range of motion at the ankle, subtalar, and midtarsal joints would be painful and restricted. Patients will be unable to bear weight on the affected foot. With fracture–dislocations, the ankle displays a marked deformity with pale skin over prominent bone fragments, rapid blistering can lead to necrosis of the skin. Closed injuries also are usually associated with severe swelling and may have elements of internal degloving, which increases the risk for wound healing complications and infections.[7]

Open fractures occur frequently, accounting for 20%–25% of injuries, with a greater incidence of fractures become more displaced [Figure 3]. Urgent surgical debridement should be undertaken. It is advisable to inspect the open wounds in the operating room. Care should be taken not to overlook talar fractures in multiply injured or polytraumatized patients. The foot is also examined for neurovascular deficits. In unconscious patients with extensive soft tissue damage compartment syndrome should be ruled out.[9]

Radiological Evaluation

The standard radiographic projections for a suspected talar neck or body fracture include an anteroposterior (AP) and lateral view of the ankle. AP and mortise views allow visualization of the talar dome as well as the lateral process, particularly osteochondral injuries and body fractures in the sagittal plane. In addition, AP view of the foot allows visualization of the talonavicular joint in that plane.[10] Lateral view of the ankle allows good visualization of the talar neck fractures. On a good lateral view, there will be a single shadow of the superior convexity of the talar body, meaning the lateral and the medial sides of the talar dome are collinear. This view allows the visualization of tibiotalar articulation, subtalar articulation, and talar navicular articulation.

The talonavicular joint is best assessed with a dorsoplantar view of the foot with the tube tilted 20° caudally. Malalignment of the subtalar joint and fractures of the lateral process may be detected with a 20° Broden's view.

However, these specific projections have lost importance with the generous use of computed tomography (CT) scanning in cases of talar fractures.[9]

Radiologic evaluation of talar body fractures should always include a CT scan, as plain radiographs may underestimate the degree of articular injury.[11] Dale *et al*. found that X-ray had a lower sensitivity (78%) for detecting and localizing talar fractures compared with CT (99%). In their series, they found the most common body fractures were dome compression (26%) followed by the lateral process (24%), and posterior tubercle (21%). The remaining isolated talar body fracture patterns consisted of sagittal shear, coronal shear, and avulsion fractures.[12] CT scan of the talus with thin cuts (1.5 mm) in the coronal and frontal planes helps in planning the surgical approach. These views will help to determine the best approach for visualization, the optimal placement of fixation, and whether impaction of fragments will prevent reduction.

Regardless of the talar fracture location, there is a high association of adjacent fracture or disruption of the talar articulations in all three main anatomic types of talar fracture. Specifically, there is a fracture of an adjacent bone in the ipsilateral foot or ankle in 77%, 72%, and 88% of talar body, neck, and head fractures, respectively.[12]

Distinguishing between talar neck and talar body fractures on radiography is difficult.[5] It is not uncommon for both radiologists and orthopedic surgeons to frequently mislabel talar body fractures as talar neck fractures. It is important to distinguish between talar neck fractures and talar body fractures because the treatments and prognosis differ.[13] If the fracture involves the talar dome or lateral process, then the fracture by default involves the talar body. In this instance, CT allows accurate description of fracture extent to a greater degree than radiography.

Magnetic resonance imaging (MRI) is rarely obtained. When it is obtained, it is done incidentally in a patient who has pain, swelling, and inability to bear weight, but otherwise normal initial radiographic imaging is sufficient to make a diagnosis. Some surgeons have used MRI to monitor for the presence of avascular necrosis (AVN) in the postoperative period;[10] however, it is not mandatory to routinely do MRI during the followup period.

Goals of Treatment

Goals of treatment include restoration of articular surface and axial alignment followed by rigid fixation of fracture to maintain alignment until fracture unites. Ideally, depending on the bone quality, integrity of fixation, and extent of soft tissue injury, early range of motion exercise is initiated to minimize stiffness. Optimal treatment relies on an accurate understanding of the injury.[7]

Nonoperative Treatment

The literature on the conservative management and the clinical outcomes of talar body fractures is very limited and is very seldom indicated.[8] Indications for nonoperative management are few as ankle joint is a major weight-bearing joint needs good articular restoration. Conservative management should be reserved for patients with undisplaced talar body fractures, nonambulatory patients, or in those with multiple comorbidities not able to tolerate surgery. Splinting, followed by short leg casting for 6 weeks until fracture union should be undertaken.[9,14] Full weight bearing is allowed at the time of complete radiographic union, usually after 8–10 weeks. It has to be borne in mind that every unsuccessful attempt at closed reduction increases the damage to the already compromised soft tissues thus further increasing the risk of severe soft tissue complications. Therefore, open reduction should be considered even in high risk patients.[9]

Surgical Management

The main goal in the treatment of talar body fractures is to restore the joint congruity of the tibiotalar and subtalar joints. Inspite of high rates of arthritis of the ankle and subtalar joints, it is the consensus opinion to manage all talar body fractures with anatomic reduction and internal fixation. Even in severely comminuted fractures attempts should be made to restore at least the tibiotalar joint.[11] The early reports available in the literature have made little mention about talar body fractures and the outcomes of their treatment. In previous studies, talar body fractures were not differentiated from other fractures of the talus, and the majority of them were treated nonoperatively.[13] Interestingly, some authors have advocated primary fusion of the tibiotalar and subtalar joint in comminuted talar body fractures.[13]

Sneppen *et al*. in their series of 21 patients with talar body fractures 18 underwent closed treatment, and three underwent open reduction and internal fixation (ORIF). They reported that talar malunion was observed in 60% of patients. They also found high rates of posttraumatic arthritis of the ankle and subtalar joints with 95% of patients having moderate or severe complaints. They suggested that anatomic reduction with stable fixation can maximize the postoperative outcome of these fractures.[15]

Elgafy *et al*. in their series reported their series of 11 fractures of the talar body of which 9 underwent initial ORIF to restore articular congruity, 1 was treated with ankle spanning external fixation and primary tibiocalcaneal fusion in 1 patient. Despite the high incidence of arthritis (90%), the authors remained optimistic, that only three of eleven patients had osteonecrosis, which is attributed to early anatomic reduction and fracture stabilization.[6] Ebraheim *et al*. reported their medium-term results of 19 patients with displaced fractures of the talar body treated by internal fixation. The clinical outcome was based on the

American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scoring and the excellent outcome was achieved in 4 patients, good in 6, fair in 4, and poor in 5.[3] Lindvall *et al.* in their series reported 88% union rates in their patients with Talar body fractures.[16]

The consequences following talar body fractures are dictated by the intensity of the initial injury, fracture comminution associated subtalar dislocation and the standard of reduction and internal fixation. The incidence of AVN is almost certainly dictated by the fracture pattern and its disruption of the intrinsic blood supply to the talus. Revascularization can be achieved by good surgical reduction and stable internal fixation. Restoration of the extraosseous blood supply can only occur with the accurate restoration of joint alignment. Further, anatomic fracture reduction and rigid internal fixation help to restore the intraosseous anastomoses, which is essential for fracture healing and revascularization of the talar body. Thus, the importance of surgical reconstruction in displaced fractures is not only to anatomically reduce the articular surfaces and restore the dimensions of the talar body but also to ensure that the remaining precarious blood supply to the talus is not iatrogenically jeopardized further.[17]

Fractures of the talar body involve both the tibiotalar and subtalar joints, and have the highest incidence of arthritis among all talus fractures[6] and hence present significant surgical hurdles for the foot and ankle surgeon. Although the talar body fractures have been classified into various fracture patterns, these classification schemes have not had any significance for treatment choices or outcome,[6,8,13,18] and there is no dogmatic way to approach all fractures, and surgical algorithms are inadequate to include all variations of the injury. Treatment of talar body fractures is based on restoring the joint integrity of the tibiotalar and subtalar joints.[13,19-21] The accurate restoration of a congruent articular surface is therefore important to minimize the risk of this complication. In patients with fracture of the talus involving the body should be explained that persistent pain and secondary

arthritis are inevitable even after anatomic reduction and good fixation.[18]

Assessment of the soft tissue envelope should guide the foot and ankle surgeon to the appropriate time for fracture reduction [Figure 3].The surgical plan should include a direct well planned surgical exposure to the fracture and allow for direct reduction and fixation, avoidance of soft tissue complications by allowing sufficient time for soft tissue edema to subside, eliminating unnecessary soft tissue dissection.

Surgical Approach

Multiple surgical approaches [Figure 4] are described that include anteromedial approach, posteromedial approach, anterolateral approach and posterolateral approach and sometimes the fracture pattern may warrant a dual approach [Figures 5 and 6]. The anteromedial approach is most commonly used and is done by making an incision medial to the tibialis anterior tendon. The incision can be extended proximally if an additional malleolar osteotomy is required. The anterolateral approach is made by an incision between the tibia and fibula in line with the fourth ray, only lateral to the extensor digitorum longus. When this approach is used in conjunction with the anteromedial approach, care should be taken to maintain adequate skin bridge to avoid skin necrosis. The posterolateral approach of the talus involves making an incision just lateral to the Achilles tendon and developing an interval between the peroneal muscles and flexor hallucis. The peroneal artery and the saphenous nerve should be protected during this approach. Isolated process fractures and osteochondral fractures can be treated with a direct surgical exposure and internal fixation or arthroscopic reduction.[1]

Usually, the fracture pattern and location will determine the choice of surgical approach.[13] Preservation of the remaining blood supply to the talus is a main concern during operative repair and can be difficult to accomplish when multiple approaches and forceful manipulations are required to gain satisfactory exposure. The most significant

Figure 4: Clinical photographs showing approaches (a) Anteromedial approach (b) Anterolateral approach (c) Medial approach (d) Lateral approach
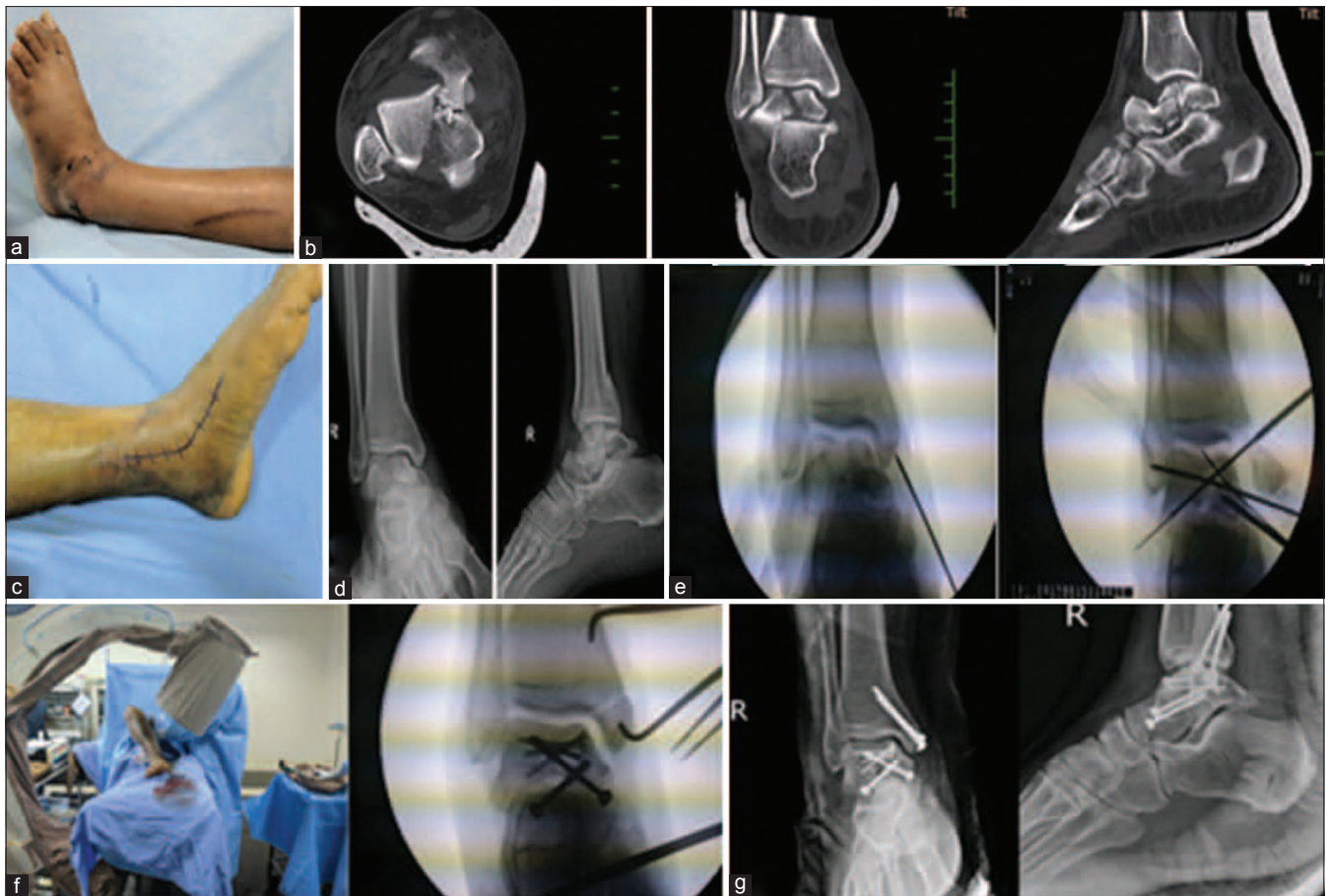
Figure 5: Talar body fracture operated by medial approach and medial malleolar osteotomy (a) Clinical photograph showing skin condition at the time of presentation (b) computed tomography view in axial, coronal and sagittal sections showing talar body fracture (c) Clinical photograph showing medial approach (d) Preoperative X-ray ankle joint anteroposterior and lateral views showint talar body fracture (e) C-arm pictures of medial malleolar osteotomy, temporary fixation with k-wire, (f) Intraoperative Canale Kelly view (g) Postoperative X-ray ankle joint anteroposterior and lateral view showing fixation of talar body medial malleolar osteotomy fixation

obstacle to proper reduction of talar body fracture is adequate exposure and these traditional surgical approaches often fail to achieve adequate exposure of the talar body, especially in the case of complex talar body fractures.

Medial malleolar osteotomy is the most common osteotomy performed for reduction of complex talar body fractures.[2] It is performed more often on the more comminuted side to allow direct access to the fracture fragments. The use of a medial or lateral malleolar osteotomy [Figure 5] is more popular and an alternative to the standard anteromedial or anterolateral approach to the talus. It is used to gain access to the talar body in situations in which the traditional approaches did not provide adequate exposure.[2] It facilitates direct exposure of the articular surface and eliminates the need for soft tissue dissection around the ankle joint. A direct transosseous approach is often made possible through an existing medial malleolar fracture. The medial malleolus is reflected inferior to expose the talar body. It is important not to violate the deltoid ligament, which is an important source of blood supply to the talar body. Moreover, osteotomy exposes the medial aspect of the body of the talus and allows the surgeon to protect the posteromedial deltoid branches from the posterior tibial artery which is the main blood supply to the body of the talus. This approach is used to expose an irreducible fracture dislocation of the talus as well as fractures of the body of the talus and complex fractures of the neck with posterior extensions [Figure 7]. The fibular door osteotomy[22] described by Hansen is valuable for complex fractures of the lateral body of the talus. The primary indication for fibular osteotomy is a comminuted lateral talar body fracture involving both the lateral plafond and the lateral talar process [Table 2].

A femoral distractor can be used in exposing multifragmentary fractures of the tibiotalar and subtalar joints. The talar dome fragments can be reduced from posterior to anterior and from lateral to medial. K-wires may be used as joysticks and to stabilize a mobile fragment [Figure 8]. The subtalar joint is assessed from the lateral (Ollier) approach for residual step-offs, or fracture distraction.[9] Body fractures can be in a coronal plane, sagittal plane, or crush injuries.[15] The sagittal plane fracture can be fixed with screws placed medial to lateral [Figure 5]. Screws need to be countersunk deep to
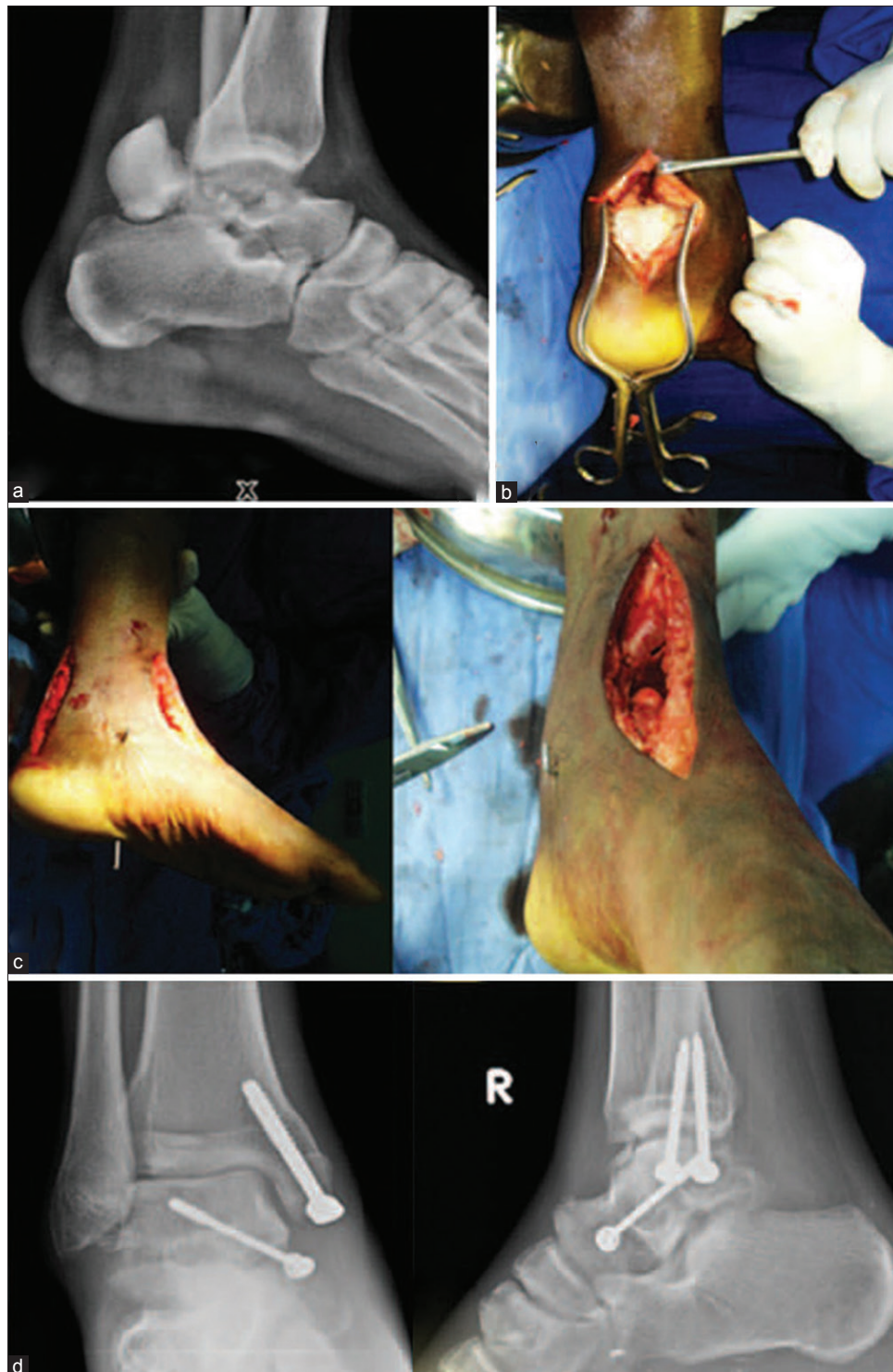
Figure 6: (a) Preoperative X-ray ankle joint lateral view showing talar body fracture with extrusion posteriorly (b and c) Intraoperative photographs showing dual medial and posterior approach (d) Postoperative X-ray anteroposterior and lateral views showing fixation of talar body and medial malleolar osteotomy

the cartilage, or headless screws may be used.[10] Lateral comminuted fractures need plate fixation [Figure 8] to avoid collapse and secondary malunion [Table 3].

Arthroscopic reduction and internal fixation (ARIF) is minimally invasive as it provides good visibility of the fracture in the frontal and sagittal planes. Cadaveric studies have shown that even 2 mm of displacement alters the biomechanics of the foot adversely. ARIF helps in anatomical reduction and fixation with interfragmentary screws under direct vision. Moreover, less interruption of soft tissues minimizes the danger of further devascularizing the talus. Arthroscopy gives easy access for fixation of the

Figure 7: X-ray anteroposterior and lateral views of ankle (a) and CT scan sagittal cut of ankle (b) showing posterior talar body process fracture Sneppens type III (c) X-ray anteroposterior and lateral views of ankle showing that it needed posterior approach and fixation

Figure 8: (a) X-ray lateral view of ankle joint showing talar body comminuted fracture (b) Peroperative photographs showing lateral and medial approach being used for fixation (c) Postoperative X-rays anteroposterior and lateral views showing talar body fixed with mini fragment plate and medial malleolar osteotomy fixed with two screws

Table 2: Pearls in osteotomy	
Medial malleolar osteotomy	**Lateral malleolar osteotomy**
1. Made by extending the anteromedial incision proximally	1. Indicated for comminution of the lateral aspect of the talar dome
2. Distal tibial plafond should not be violated	2. Perform osteotomy 5 cm proximal to the tip of lateral malleolus
3. Visualize the joint surface before osteotomy	3. Ostetomy should be transverse to facilitate compression plating at the end of surgery
4. Predrill and pretap the medial malleolus	4. Anterior distal tibiofibular ligament can be incised to facilitate rotation of the lateral malleoli
5. Place small anterior and posterior retractors to protect the dome of the talus and the posterior tibial tendon	5. Protect anterior and posterior talofibular ligament, calcaneofibular ligament and the peronei
6. Retain the soft tissue distally (deltoid ligament) to preserve the blood supply of medial malleolus	

fracture in the posterolateral to the anteromedial plane, which is considered strong biomechanically.

Satisfactory results have been achieved in arthroscopically assisted fixation of ankle fractures. Other studies have also shown successful treatment of and in the management of osteochondral lesions of the talus. However, no such results have been reported in the management of talar fractures with articular involvement.[23] The currently available literature regarding ARIF of talar fractures is very limited to few case reports. The advantage of Arthroscopy is that it enables the identification of intraarticular loose bodies, cartilage injuries, and transchondral defects that are radiologically insignificant.[24] Case reports on talar body fractures have reported Satisfactory outcomes at the end of 1-year followup.[25] It is ideally indicated for 2-part fracture without severe soft tissue damage. Furthermore, arthroscopy may be combined with ORIF for comminuted fractures that require removal of loose bodies. However, more complex fracture patterns are difficult to manage with arthroscopy alone and associated soft tissue involvement in these fractures carries an increased risk of saline leakage or compartment syndrome. The arthroscopic approach depends on the fracture pattern with anterior arthroscopy typically indicated in fracture involving the anterior two-thirds of the talus and in longitudinal fractures. Injuries involving the posterior one-third of the talus is ideally dealt with posterior arthroscopy.[26]

Sometimes patients may present with neglected fractures or after native treatment with traditional bone setters. These situations are extremely challenging and careful clinical evaluation, radiological evaluation for the onset of AVN and posttraumatic arthritis, patients age, demands, should be considered for appropriate planning of surgery. Since the incidence of posttraumatic arthritis is as high as 65% even in acute talar body fractures, primary arthrodesis is an alternative in these neglected situations.

Postoperatively, the foot should be immobilized in a nonweight bearing cast for 6 weeks. It is ideal to maintain the ankle in a dorsiflexed position to ensure bony reduction of the talar dome and minimize anterior scar tissue formation. After 6 weeks, gentle, nonweight bearing range of motion of the subtalar and ankle joints should begin. Nonweight bearing should be continued for a full 12 weeks; thereafter, it should be advanced as tolerated.[6,16,17,27]

Complications

Fractures of the talar body is associated with increased rates of complications such as AVN, malunion, nonunion, late osteoarthritis, ankylosis of subtalar joint, skin infection, and subsequent necrosis. The incidence and severity of these complications are related to several factors including the intrinsic talar vascular supply, the initial extent of displacement, the presence of associated dislocation and the adequacy of reduction.[28] This associated with the fact that more weight per area is borne by the talar dome than any other joint in the body means that posttraumatic arthritis and long standing disability are frequent complications to fractures of the talus.[29] Even with accurate and appropriate surgical care morbidity is common. Sanders *et al.*,[30] showed the need for secondary reconstructive surgery in 1 year was 24% and increased to 48% at 10 years. In addition, varus malalignment led to more pain and lower functional outcome scores when compared with patients in which alignment was evaluated as normal. The most common reason for secondary surgery was subtalar arthritis.[30]

Arthritis

Fractures of the body of the talus were associated with the highest incidence of degenerative joint disease of both the subtalar and ankle joints.[6] A study by Vallier *et al.* found 65% incidence of posttraumatic tibiotalar arthritis and 34% incidence of posttraumatic subtalar arthritis. Lindvall *et al.* in their series of 26 patients found 100% incidence of posttraumatic arthritis. Poor outcomes were observed in association with severely comminuted fractures, open injuries and associated talar neck fractures. Sneppen *et al.* found that in patients with significant talar compression, 50% of patients had ankle osteoarthritis; if the talus exhibited a shearing pattern of injury, the incidence of posttraumatic arthritis in both the ankle and subtalar joints was 41%. They concluded that results in talar body fractures are directly related to the severity of the initial injury and emphasized that if subluxation and articular damage to the subtalar and talotibial joints occurred at the initial injury, long term prognosis is poor.[3] Arthritis in the ankle and subtalar joints can occur in the absence of AVN of the talus and joint incongruity. Hence, the patients with these injuries should be explained on the long term complications, and that secondary osteoarthritis is expected in displaced talar body fractures inspite of accurate reduction with stable fixation [Table 4].

Table 3: Techniques of reduction

1. First step to reconstruct the talar dome is to dis-engage all the fracture fragments
2. Visualize the subtalar joint and clear the debris
3. Elevate and graft impacted fractures
4. Impaction on the subtalar side should be addressed first
5. Reduce the fracture fragments and pin them into place
6. Talar dome is reduced from posterior to anterior and from lateral to medial
6. Only after complete reduction of the body permanent fixation should be done
7. Permanent fixations should lie in the medial or lateral gutter

Table 4: Incidence of posttraumatic arthritis

Studies	Incidence (%)
Vallier *et al.*[13]	
Tibiotalar joint	65
Subtalar joint	35
Lindvall *et al.*[16]	100
Sneppen *et al.*[15]	95
Elgafy *et al.*[6]	27
Ohl *et al.*[31]	94

Table 5: Acceptable hind foot alignment following treatment of talar body fractures

Position	Alignment
Normal	4°-8° of valgus
Varus malunion	<4° of valgus
Valgus malunion	>4° of vagus

Table 6: Incidence of infection

Studies	Incidence (%)
Rammelt and Zwipp.[9]	3-8
Elgafy *et al.*[6]	6.6
Vallier *et al.*[13]	9
Ohl *et al.*[31]	10

Table 7: Pearls to reduce infection rates

1. Avoid repeated attempts of closed reduction
2. Urgent surgical debridement in open fractures
3. Early reduction of associated fracture dislocations
4. Delayed defnitive care in closed fractures with significant soft tissue swelling

Table 8: Incidence of avascular necrosis

Studies	Incidence (%)
Vallier *et al.*[13]	27
Lindvall *et al.*[16]	50
Ebraheim *et al.*[3]	37
Ohl *et al.*[31]	20
Elgafy *et al.*[6]	27

Malunion and nonunion

Nonunion after talar neck or body fractures is rare, occurring in <5%. The rate of malunion in previous reports varies between 0% and 37% and is likely underestimated due to limitations in assessing articular and axial malalignment with plain radiography. Malunion will generate pain and reduce the mobility of the subtalar and transverse tarsal joints.[7] Malunion is mostly in varus, and the risk is mainly influenced by the initial quality of reduction or the fracture type but also by the osteosynthesis technique. To avoid this, Thordarson recommends the use of neutralization (noncompression) screws for cases with comminution at the fracture site. Ohl *et al.* observed a high rate of varus malunion (all fracture types taken together) with compression screws and caution is necessary with the use of such screws.[31]

On postoperative radiographs, the quality of reduction in AP and lateral views could be assessed according to the criteria proposed by Lindvall *et al.* An anatomical reduction meant that there was no step-off at the neck or body and no frontal angulation. A nearly anatomical reduction was defined as a 1 mm to 3 mm step-off of any fracture fragment or slight varus angulation (≤5°). A poor reduction was an articular or neck mismatch, a step-off or gap of >3 mm, or neck angulation of >5°.[28] Analysis of the subtalar joint can also use to rate the quality of the reduction. Radiographs of the foot and ankle should be done at approximately 6-week, 12-week, 6-month, and 12-month intervals postoperatively and were used to look for a secondary displacement, time to union, and AVN. Ohl *et al.* reported 25% malunion rates in their series of talar body fractures[31] [Table 5].

Infections

Infections occur predominately after open fractures of the talus. Rammelt and Zwipp noticed superficial infections in 6.2% and deep infections in 3.1% of cases. The overall infection rates range between 3% and 8%.[9] While superficial wound edge necrosis usually heals with rest and antiseptic dressings, deep soft tissue infections require radical debridement of all infected and necrotic tissue, copious lavage, occasionally hardware removal, external fixation, continuous drainage (if possible with vacuum-assisted systems), and the administration of antibiotics. The most dreaded complication is septic necrosis of the talar body requiring partial or total talectomy, temporary placement of antibiotic polymethylmethacrylate-beads, and secondary tibiocalcaneal fusion. Soft tissue reconstruction regularly requires plastic coverage with either skin grafting, pedicle, or free flaps[9] [Tables 6 and 7].

Avascular necrosis

AVN is a common complication after talar fractures. The rates of AVN are dependent on the type of fracture, degree of displacement, and the type of surgical approach.[32]

Osteonecrosis of badly comminuted talar body fracture is reported in around 50%–75% of cases.[3] A study by Vallier *et al.* found 38% incidence of AVN and Lindvall *et al.* in their series of 26 patients found a 50% incidence of AVN. Many authors agree that initial degree of fracture displacement is an important risk factor for osteonecrosis. However, timing of fixation did not appear to affect the outcome, union, or prevalence of AVN.

Gomes de Sousa *et al.*, in their series of a few cases found that fractures of talar body had a benign prognosis" regarding their functional impact in the long run than the neck fractures. However, Lindvall *et al.* in a direct comparison of fractures of the body and neck[18] found no statistically significant difference between the AOFAS score, rates of osteonecrosis, or prevalence of posttraumatic osteoarthritis[33] [Table 8].

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Conflicts of interest

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