Review Article

Talus Fractures: Evaluation and Treatment

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Abstract

The talus is unique in having a tenuous vascular supply and 57% of its surface covered by articular cartilage. Fractures of the head, neck, or body regions have the potential to compromise nearby joints and impair vascular inflow, necessitating surgical treatment with stable internal fixation in many cases. The widely preferred approach for many talar neck and body fractures is a dual anterior incision technique to achieve an anatomic reduction, with the addition of a medial malleolar osteotomy as needed to visualize the posterior talar body. Percutaneous screw fixation has also demonstrated success in certain patterns. Despite this modern technique, osteonecrosis and osteoarthritis remain common complications. A variety of new treatments for these complications have been proposed, including vascularized autograft, talar replacement, total ankle arthroplasty, and improved salvage techniques, permitting some patients to return to a higher level of function than was previously possible. Despite these advances, functional outcomes remain poor in a subset of severely injured patients, making further research imperative.

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Talus fractures are rare but disabling injuries to the hindfoot and remain challenging to treat, despite recent advances in management.[1] Multiple articulations, tenuous blood supply, and complex structure create particular difficulty in achieving acceptable outcomes even with optimal treatment. Adding to these challenges, the incidence of talus fractures is anticipated to increase because improving passenger safety in motor vehicle collisions increases survivorship without commensurate declines in foot trauma.[2]

Anatomy

The osteology of the talus can be conceptualized as a domed box (the body) with a stout cylinder (the neck) projecting anteriorly. The superior articular dome is wider anteriorly than posteriorly, lending greatest stability to the tibiotalar joint in dorsiflexion. The anteriorly projecting talar neck is angled medially and plantarly and terminates in the ellipsoid talar head. Two bony processes protrude from the talar body. The posterior process extends posteromedially from the body and consists of posteromedial and posterolateral tubercles separated by a central sulcus through which the flexor hallucis longus tendon passes. The lateral process extends inferolaterally and bears articular cartilage both superiorly (facing the fibula) and inferiorly (facing the calcaneus). Inferiorly on the talar body, three facets articulate with the calcaneus, comprising the subtalar joint. A deep bony groove divides the anterior and middle facets and the posterior facet. This groove widens out into the sinus tarsi laterally.

A mean 57% of the talar surface is covered by articular cartilage.[3] This unique anatomic feature presents three challenges when treating talus injuries: (1) relatively little surface area is available for vascular inflow, (2) fracture displacement readily impairs the mechanics of nearby joints, and (3) access for surgical treatment requires navigating tight constraints.

High rates of talar osteonecrosis have motivated the investigation of the vascularity of the talus (Figure 1). Quantitative MRI has revealed contributions to talar blood supply by three major arteries: 47% from the posterior tibial artery, 36% from the anterior tibial artery, and 17% from the peroneal artery.[4] A branch of the posterior tibial artery, the artery of the tarsal canal, passes caudal to the talar neck between the posterior and middle facets and is the single most notable vessel supplying the talus. There is a dense cluster of vascular nutrient foramina on the underside of the talar neck, where the artery of the tarsal canal anastomoses with the artery of the tarsal sinus, derived from anterior tibial circulation.[3] Although the talar body was historically thought to receive nearly all blood flow in a retrograde manner from the talar neck, radiographic and plastination studies of cadaver tali have demonstrated concurrent antegrade flow entering the posterior tubercle through an anastomosis between the peroneal and posterior tibial circulations.[3–5]

Figure 1

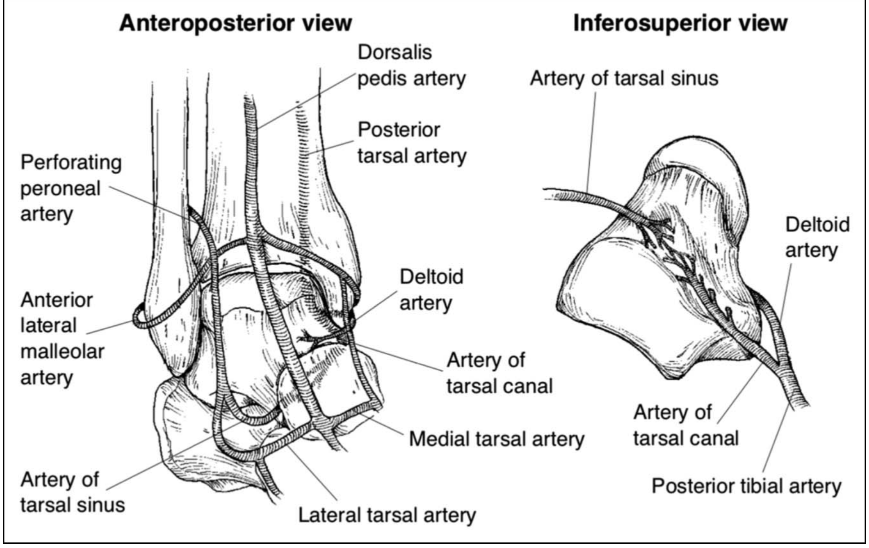


Illustration showing the blood supply to the talus.[6]

Epidemiology and Classification

The incidence of talus fractures has increased in recent decades. Although previously comprising 0.85% to 1% of all fractures,[5,6] recent epidemiologic data suggest that talus fractures may constitute close to 2% of all fractures.[7,8] This may be related to motorcycle and motor vehicle collision-related foot trauma as patients increasingly survive more severe injuries.[2]

Talus fractures are classified by anatomic region into head, neck, and body fractures. Neck fractures are subclassified by how many nearby articulations are disrupted based on observations in the historical case series of Hawkins and Canale.[6] Type I fractures are nondisplaced, type II fractures exhibit subtalar subluxation or dislocation, type III fractures disrupt subtalar and tibiotalar joints, and type IV fractures disrupt subtalar, tibiotalar, and talonavicular joints.[6] Vallier et al[9] proposed dividing type II injuries into IIA, with subtalar subluxation, and IIB, with subtalar dislocation, because mere subluxation seems to beget a 0% rate of osteonecrosis and dislocation is associated with a 25% rate of osteonecrosis. The relative incidence of each Hawkins type in a 2013 systematic review was 22% type I, 43% type II, 31% type III, and 4% type IV.[1]

Acute traumatic talar body fractures are differentiated from talar neck fractures on the basis of the inferior fracture line exiting into or posterior to the lateral process.[6] Although no universal subclassification of talar body fractures exists, lateral and posterior process fractures are typically differentiated from those through the talar dome. Despite the greater historical attention talar neck fractures have received, talar body fractures have been found to be slightly more common in recent series,[10,11] constituting 53% to 60% of all talus fractures.

Evaluation

The initial evaluation of traumatically injured patients with a suspected talus fracture proceeds according to the Advanced Trauma Life Support protocol. The examination should include a survey for other orthopaedic injuries, especially ipsilateral extremity injuries, which accompany talus fractures at a rate of 48% to 59%.[12,13] A CT scan should be obtained when there is clinical suspicion for a talus fracture because the sensitivity of plain radiographs for CT-detected fractures is 74% to 78%.[11] The skin and neurovascular status of the foot and ankle should be carefully

Figure 2

Radiograph of a 55-year-old man after a fall from a moving vehicle presenting with a left open talar head fracture/dislocation. **A**, AP image demonstrating extruded talar head. **B**, Lateral image demonstrating talar head extrusion. **C**, Intraoperative fluoroscopy showing fixation with a lateral plate and two medial screws. **D**, Intraoperative fluoroscopy showing reduction and fixation of the talar neck.

Figure 3

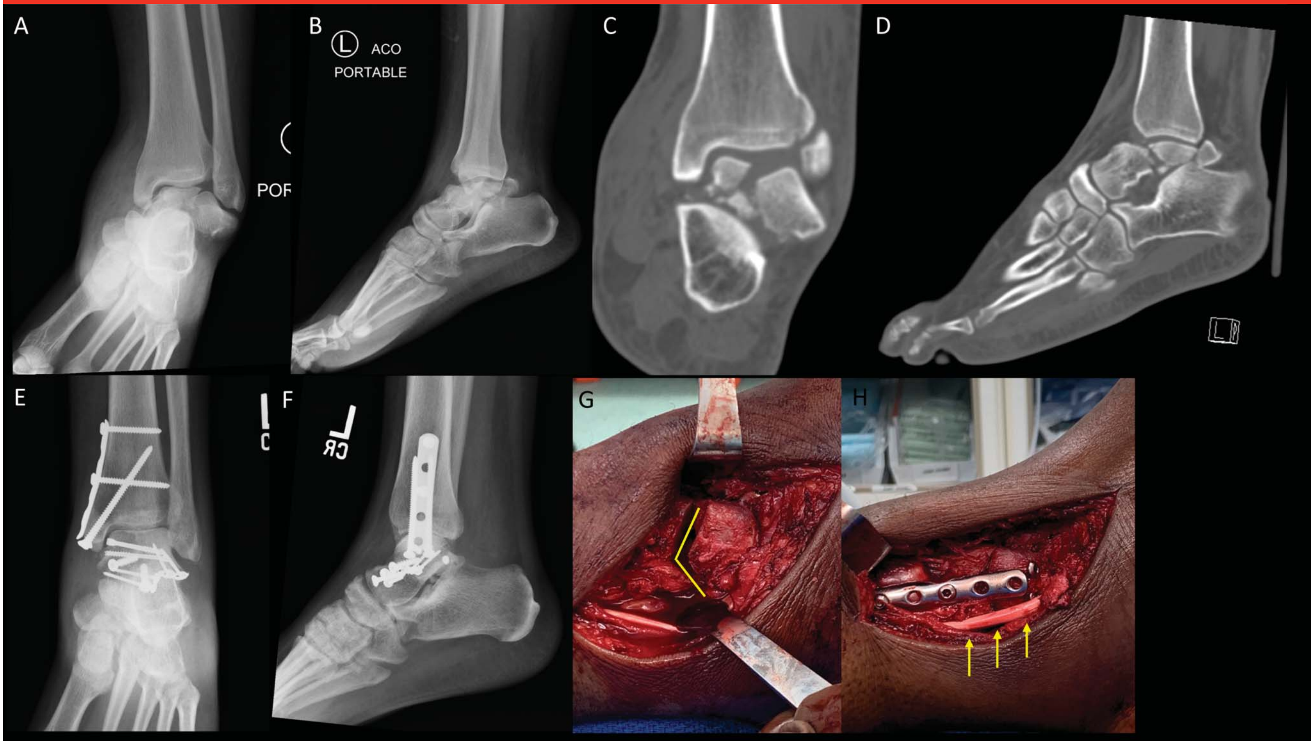
Radiograph showing a Canale view obtained by maximally plantar flexing the foot, pronating the foot 15° to decrease overlap of the talus and calcaneus, and angling the imaging device 75° up from the horizontal.

assessed. A dislocated talar body can compromise both skin and neurovascular structures, thereby necessitating urgent surgical reduction.[6] Dislocations can receive a single attempt at closed reduction with manipulation in the emergency department, although general anesthesia is frequently required to achieve reduction. In open injuries, intravenous antibiotics and tetanus prophylaxis should be administered and sterile dressings applied.[12] Dislocated tali extruded through an open wound should undergo immediate irrigation with normal saline and be reduced into the wound.[14] If an extruded talus has no soft-tissue connections, it can be placed in a sterile antimicrobial solution and transported with the patient to the operating room before being cleaned and reimplanted (Figure 2), a strategy reviewed in one series of 19 patients and found to result in infection in only 2 of the 19.[14]

Although displaced neck fractures were historically considered surgical emergencies because of a concern regarding disrupted retrograde circulation to the body, the few studies that have compared early versus delayed surgical treatment have not shown differences in osteonecrosis rates.[15] A 2017 systematic review found the average interval from injury to surgery in six studies to be 2.36 days.[16] The most modern approach seems to be urgent reduction of any dislocations, with either concomitant definitive fixation or delayed fixation being acceptable after reduction is obtained.[9,17]

Standard imaging for fractures of the talus includes a routine foot series (AP, lateral, and oblique) and an ankle series (including AP and mortise) in addition to a CT of the foot. Radiographic views specific to the evaluation of talus injuries have been described, however, are more frequently used for intraoperative than preoperative assessment. The most important is the Canale view, a true anterior-posterior view of the talar neck (Figure 3).[6] This is obtained by maximally plantar flexing the foot, pronating the foot 15° to decrease overlap of the talus and calcaneus, and angling the imaging device 75° up from the horizontal.

Figure 4



The patient is a 46-year-old man presenting with a left comminuted talar body fracture. **A**, AP radiograph showing the talar body fracture with partial extrusion of the lateral body. **B**, Lateral radiograph showing the comminuted talar body fracture. **C**, Coronal CT cut showing a midsagittal split with medial comminution of the talar body. **D**, Sagittal CT cut again demonstrating notable comminution of the talar body. **E**, AP radiograph showing the final fixation. **F**, Lateral radiograph showing the final fixation. **G**, Intraoperative photograph of the chevron medial malleolar osteotomy. **H**, Intraoperative photograph of the medial malleolar osteotomy after the final fixation. The yellow arrows indicate the posterior tibial tendon.

Treatment

The indication for surgical fixation of the talar neck and body fractures is any notable displacement. Cadaver models have shown that as little as 2 mm of talar neck displacement leads to a more concentrated high-pressure contact area in the middle and anterior facets of the subtalar joint[18] and that varus malalignment of the talar neck decreases subtalar motion by 24% to 32% in each plane.[19] In historical series, many displaced fractures were treated nonsurgically and varus malunion was a frequent result.[6] In a 2004 review of the functional outcomes of 70 patients at an average 5-year follow-up, hindfoot malalignment due to malunion was the single most salient predictor of pain, dysfunction, and the need for secondary surgeries.[13] These findings led to a current recommendation that nonsurgical treatment be reserved for truly nondisplaced injuries.[20] Reflecting the increasing rarity of nonsurgical treatment of talar neck fractures, Dodd and Lefaivre[15] reported that 96% of cases reported from 2000 onward were treated surgically.

Neck

The widely preferred approach for surgical treatment of talar neck fractures is a dual anterior incision technique.[9,13,17,20,21] The anteromedial approach provides access between the tibialis anterior and tibialis posterior tendons. An incision is made from the medial ankle joint to the navicular-cuneiform joint. The long saphenous vein is protected, and dissection is carried down to the superomedial talar neck. Dissection along the neck itself should be minimized as much as possible.[22] This incision can also be adjusted if preoperative planning identifies the possible need for a medial malleolar osteotomy. The anterolateral approach is between the peroneus brevis and tertius. An incision is made from the distal syndesmosis (anterolateral corner of the ankle) toward the fourth metatarsal. The superficial peroneal nerve is protected, and the sinus tarsi fat pad and extensor digitorum brevis origin are elevated to expose the superolateral talar neck and lateral process. Alternatively, a sinus tarsi approach can be used as the lateral window, with a slightly more plantar incision from the distal fibula toward the fourth metatarsal which may afford easier visualization of the lateral process.

The combination of anteromedial and anterolateral incisions facilitates anatomic reduction because talar neck fractures are frequently comminuted on the medial side (failing in compression) and noncomminuted on the lateral side (failing in tension). A dual incision approach allows reduction maneuvers to be performed while simultaneously visualizing both aspects of the fractured neck, thus helping to prevent rotational and angular malreductions. Reduction of medial and lateral cortices should be confirmed under direct visualization and fluoroscopy (AP or Canale view) before proceeding with fixation.

Fixation can be performed with dual minifragment plates, a combination of plating and positional screws or screws alone.[17,20] Longitudinal lag screws, particularly on the medial side, are often contraindicated because overcompression through medial comminution may cause varus collapse.[17] With dual plating, the lateral plate spans from just anterior to the lateral process to the lateral head-neck junction and the medial plate spans from plantar to the medial talar body cartilage to the medial head-neck junction. Another fixation option is a posterolateral to anteromedial percutaneously placed lag screw, with or without a medial anterior-to-posterior positional screw.[22] Although screw fixation may reduce dissection of the talar neck's tenous vascular supply, the biomechanical strength and ability to maintain an anatomic reduction may be superior with plate fixation. Thus far there is no clinical evidence of the superiority of either technique,[17,22,23] and biomechanical data are similarly inconclusive.[24,25] One biomechanical study compared screws alone with screw and blade plate fixation and found no notable differences in yield point, stiffness, or load to create a 3 mm deformation.[24] Notably, the screws failed with bending or pullout and plate fixation failed with a fracture at the margin of the plate. Smaller, more flexible plates may not produce the same failure mechanism. Another caveat was that the screws used were conventional 3.5 cortical or 4.0 cancellous screws. Headless variable-pitch screws may improve fixation strength relative to conventional cannulated screws.

Body

The principles of talar body fracture treatment overlap with those of talar neck fracture treatment, with the additional challenge of visualizing the talar dome. Dual anterior approaches are typically used, with the occasional addition of a medial or lateral malleolar osteotomy to facilitate exposure (Figure 4). One cadaver investigation demonstrated that dual anterior incisions expose approximately the anterior half of the talar dome, suggesting that osteotomy is useful for posterior fracture planes.[26] In the series by Vallier et al[12] in 2003, of 57 talar body fractures, 65% were treated with dual anterior approaches, 28% necessitated a medial malleolar osteotomy, and 5% necessitated a lateral malleolar osteotomy.

One of the earliest descriptions of medial malleolar osteotomy for talar body fractures is credited to Ziran et al.[27] The technique involves an initial extension of the anteromedial incision along the medial malleolus. Anteriorly, capsule is released up to the axilla of the medial plafond and posteriorly, the posterior tibial tendon is partially released from its sheath and retracted. The osteotomy is performed obliquely with an oscillating saw directed toward the medial shoulder. The cut is completed with an osteotome to minimize damage to the articular surface and facilitate cartilage interdigitation on repair. It is thought to be important that the cut passes perpendicularly through the articular cartilage at the medial axilla of the joint to permit a congruent articular surface to be restored. van Bergen et al[28] analyzed the optimal osteotomy angle, finding the optimal cut to be angled 60° up from the horizontal (line drawn across tibial plafond), corresponding to 30° down from the longitudinal tibial axis. van Bergen et al[28] further described the use of two arthroscopic right-angled aiming probes, placed in the anterior and posterior axillas of the medial plafond, to find the ideal cut plane.

Other described techniques include step cut and biplanar chevron techniques. The step cut technique was found to be highly reliable in one series of 14 patients, with prompt healing by 6 weeks and no loss of reduction.[29] The biplanar chevron technique was found in another series to produce an unacceptably high malunion rate of 30% unless fixed with a buttress plate rather than two lag screws.[30] Fixation placement should be mindful of future procedures, including tibiotalar arthrodesis or total ankle arthroplasty. In the relatively common case of a medial malleolus fracture accompanying a talar body fracture, the talus can be exposed through this fracture plane.

Process

Approximately 20% of fractures of the talus involve a fracture to the lateral process.[11] This has been termed the "snowboarder" fracture because of its association with the dorsiflexion and eversion fall mechanism commonly seen in snowboarding injuries.[31] CT is considered

Table 1

Treatments for Common Complications of Talus Fracture

Complication	Treatment	Reference(s)
Osteonecrosis	Joint-sparing	
	Vascularized autograft	Nunley, 2017[41]
	Joint-sacrificing	
	Talar body prosthesis	Harnroongroj, 2015[42]
	Total talar prosthesis	Taniguchi, 2015[43]
	Salvage	
	Arthroscopic fusion	Kendal, 2015[45]
	Retrograde tibiotalocalcaneal fusion	DeVries, 2010[46]; Tenenbaum, 2015[47]; Abd-Ella, 2017[48]
Osteoarthritis	Single joint	
	Total ankle arthroplasty	Norvell, 2019[34]; Veljkovic, 2019[35]
	Open versus arthroscopic ankle fusion	Veljkovic, 2019[35]
	Open versus arthroscopic subtalar fusion	Rungprai, 2016[36]
	Multiple joint	
	Retrograde tibiotalocalcaneal fusion	Tenenbaum, 2014[47]
	Simultaneous subtalar fusion and total ankle arthroplasty	Usuelli, 2016[38]
	Total ankle arthroplasty with total talar prosthesis	Kanzaki et al[37]

essential for proper diagnosis because the size of a lateral process fracture may be underestimated on plain radiographs. Although many lateral process fractures were treated nonsurgically or with excision in historical series, the outcomes were poor, likely because of underappreciation of the important contribution of the lateral process to the subtalar joint.[32] The trend more recently has been toward surgical treatment with open reduction and internal fixation.[32] Isolated lateral process fractures can be approached with an anterolateral approach similar to that described above, with the proximal extent of the incision beginning slightly more lateral, at the tip of the fibula.[20] A small diameter lag screw or small diameter buttress plate along the inferolateral talar neck can be used for fixation. It is additionally important to address ligament injuries associated with this fracture because ankle instability can remain with bony fixation alone. The authors of a recent series recommended that nonsurgical treatment be reserved for nondisplaced, small-fragment and extra-articular fractures.[32]

Posterior process fractures are associated with approximately 18% of talus fractures.[11] It is important not to confuse small posterior process fractures with a symptomatic os trigonum. Similar to lateral process fractures, the extent to which larger posterior process fractures involve the subtalar joint may be underappreciated on plain radiographs and CT imaging is therefore essential to planning treatment. Small, nonreconstructable posterior process fragments can be excised, but large fragments should be fixed to restore the subtalar joint surface. If fixation is indicated, a posteromedial approach can be used between the medial malleolus and the medial border of the Achilles tendon, with dissection adjacent to the flexor hallucis longus tendon and neurovascular bundle.[20]

Head

Talar head fractures represent 5% to 10% of talus fractures.[11] Similar to lateral and posterior process fractures, most reconstructable fragments should be fixed to restore proper joint mechanics. The talar head is an essential component of the medial column of the foot that helps maintain the longitudinal arch. In a recent surgical technique study, a dual incision technique was used, and medial-to-lateral screws recessed into subchondral bone, or a medial column spanning plate, were used for fixation.[33]

Complications

Osteoarthritis

Osteoarthritis (OA), most frequently of the subtalar joint, is the most common overall complication after talar neck and body fractures.[15] OA is also the complication most likely

Figure 5

Radiograph showing the Hawkins sign present in a 46-year-old man 2 months after the treatment of a talar neck fracture.

to lead to secondary reconstructive surgery after talar neck fracture,[9,13] accounting for 18 of 26 secondary surgeries in the 2004 series by Sanders et al,[13] Published series with long-term follow-up data report subtalar arthritis developing eventually in most of the cases of the talar neck fracture.[15] Tibiotalar arthritis occurs approximately half as frequently as subtalar arthritis, typically in conjunction with subtalar arthritis rather than in isolation.[1,13] In talar body fractures, isolated tibiotalar arthritis does occur; the rate of tibiotalar arthritis in the 2003 series by Vallier et al[12] after a mean 33-month follow-up was 65%, with 35% exhibiting subtalar arthritis.

Treatment options for tibiotalar arthritis include arthrodesis and total ankle arthroplasty (Table 1). Total ankle arthroplasty has been favored in some studies relative to arthrodesis with improved functional outcomes and better capacity to restore optimal gait mechanics than arthrodesis,[34] although the rates of subsequent surgery may be higher after arthroplasty relative to arthrodesis.[35] The preferred approach for subtalar arthritis is arthrodesis. A recent retrospective review of 121 cases comparing arthroscopic with open techniques demonstrated improved pain and function in both groups, equivalent union and complication rates, and earlier return to work and activities of daily life in the arthroscopic group.[36]

An emerging solution for pantalar OA is total ankle arthroplasty with total talar prosthesis. In 22 patients with a mean 35-month follow-up treated with this technique, functional scores, pain, and range of motion improved markedly.[37] This remains to be compared with combination subtalar fusion and total ankle arthroplasty, which has also demonstrated favorable functional outcomes in small series.[38]

Osteonecrosis

Osteonecrosis or avascular necrosis has long been the most dreaded complication in the treatment of talus fractures, albeit second to subtalar arthritis in frequency. A 2015 systematic review of 26 studies with 980 fractures demonstrated osteonecrosis in 31% overall, with rates of 10%, 27%, and 53% across Hawkins types I through III, respectively.[15] Looking specifically at studies published after 2000, the overall rate was 25%, with 8%, 21%, and 45% across types I though III, suggesting that improved techniques may have slightly decreased the rate of osteonecrosis.[15]

Talar dome subchondral lucency, the Hawkins sign, is a reassuring sign of talar revascularization seen on radiographs in some patients at the 6 to 9 week time point (Figure 5).[39] The presence of a Hawkins sign is considered to reliably exclude the possibility of osteonecrosis, although its absence is nonspecific.[39]

The most common diagnostic criterion for osteonecrosis is increased radiodensity of the talus relative to adjacent osseous structures.[15] The mean time point for this appearance in one recent series was 6.9 months, with a range from 3 to 9 months.[9] MRI may permit earlier diagnosis but can be confounded by metallic artifact. With no agreed on interventions for early osteonecrosis, MRI has not yet become widely favored.

Little consensus exists regarding the treatment of osteonecrosis.[40] Although a period of prolonged non-weight-bearing (beyond 3 months) was encouraged historically, this was not shown to prevent progression or collapse and has largely fallen out of favor.[40] Other nonsurgical treatments include patellar tendon-bearing bracing treatment that has demonstrated limited efficacy in isolation and extracorporeal shock wave therapy, which has shown promising results in a single trial but remains experimental.[40] A period of initial observation may be warranted. After the initial diagnosis of osteonecrosis, many patients may eventually demonstrate revascularization without collapse, as did 44% of osteonecrosis cases in a 2014 series.[9] In addition, many patients with radiographic osteonecrosis may be asymptomatic. In one review of 114 fractures with a mean 9-year follow-up, osteonecrosis occurred in 39, 16 were symptomatic, and eight were found to have talar dome collapse by the final follow-up.[10]

Persistent symptomatic osteonecrosis may be treated surgically (Table 1). Three general categories of procedures are available: joint-sparing (core decompression and vascularized bone grafting), joint-sacrificing (talar replacement), and salvage

Figure 6

The patient is a 56-year-old man presenting with osteonecrosis of the right talar body. **A**, AP radiograph of the talar neck fracture with subsequent osteonecrosis of the talar body. Lateral radiograph showing osteonecrosis of the talar body. **B**, AP radiograph 2 years after hindfoot fusion nail and iliac crest bone graph demonstrating a fused tibiotalar joint. Lateral radiograph showing a fused tibiotalar joint.

(arthrodesis).[40] Joint-sparing procedures aim to preserve native talus anatomy by inducing healing of the devascularized area. Core decompression has been shown to improve functional outcomes in patients with atraumatic osteonecrosis; however, there is little documented experience in posttraumatic cases.[40] A more promising joint-sparing treatment may be vascularized bone grafting from the cuboid. In a recently reported series of 13 patients who underwent this treatment, notable improvement in health-related quality of life was demonstrated with treatment failure in 2 of 13.[41] Postoperative MRI demonstrated partial return of the marrow signal in the necrotic talus, indicating some revascularization.

Two research groups in Japan and Thailand have investigated a joint-sacrificing, but motion-sparing, treatment of talar osteonecrosis, talar body, or total talar prostheses.[42,43] Harnroongroj and Harnroongroj[42] reported 10- to 36-year follow-up data on 33 stainless steel talar body prostheses, 26 of which treated posttraumatic osteonecrosis. At the final follow-up, 5 prostheses had failed and 28 were still in place. All 28 patients with the prosthesis still in place could use a bicycle, walk on a smooth surface, and ascend and descend stairs. Taniguchi et al designed an alumina ceramic total talar prosthesis, custom-made based on a contralateral talus CT. They reported 2- to 8-year follow-up data in a 2015 study.[43] The range of motion was maintained with a mean 5.4° of dorsiflexion and 32° of plantar flexion; all patients reportedly had returned to work and activities of daily living, pain scores improved, and no infections were found.

Despite these promising early results with joint-sparing and joint-sacrificing treatments, the most common surgical treatment of talar osteonecrosis remains salvage treatment with arthrodesis (Figure 6). One option for talar osteonecrosis involving the ankle joint is tibiotalar fusion, either open or arthroscopic-assisted. Current data slightly favor the arthroscopic-assisted technique; a 2018 systematic review reported improved clinical scores and decreased complication rates with the arthroscopic technique, although union rates were similar.[44] Kendal et al[45] reported on 15 patients with talar osteonecrosis treated with the arthroscopic-assisted technique, resulting in successful fusion in all cases and resolution of pain in 13 of 15. Three patients required a second surgery for subtalar arthrodesis.

The most common arthrodesis technique for talar osteonecrosis in recent series has been tibiotalocalcaneal (TTC) fusion with a retrograde intramedullary rod.[40,46–48] This can be combined with the use of structural femoral head allograft,[40] autograft from the fibula,[49] or posterior iliac crest autograft[48] to address large bone defects. Functional results are overall favorable with TTC arthrodesis. Tenenbaum et al[47] reported on 14 posttraumatic cases with mean a 26-month follow-up. All achieved bony union, 42% needed an ambulatory aid, and the mean

American Orthopaedic Foot and Ankle Society (AOFAS) scores improved from 33 to 72. Abd-Ella et al[48] reported a 23-month follow-up of 12 posttraumatic cases and reported initial osseous union in 67%, subsequent union after revision surgery in an additional 25%, and improvement in mean AOFAS scores from 39 to 77. In addition to favorable subjective functional outcomes, TTC arthrodesis improves objective gait measures such as gait velocity and ankle moment.[50]

Outcomes

Functional outcomes after fractures of the talus, corresponding to the pattern predicting osteonecrosis and OA, correlate with increasing disruption of the peritalar joints. The AOFAS scores of 74 talar neck fractures included in a recent systematic review were 77, 86, 68, and 68 for Hawkins types I to IV.[16] A 2004 series of 70 displaced talar neck fractures with median 5.2-year follow-up remains one of the most instructive single series on functional outcomes after talar neck fracture.[13] Twenty-six patients required secondary reconstructive surgery, mostly arthrodesis, including 13 within 12 months and 13 after 12 months. The 20 patients who did not require reconstructive surgery and healed without malalignment or developing arthritis had "virtually normal function" with minimal pain and disability. In the series by Vallier et al[12] of 57 talar body fractures with a mean 33-month follow-up, 15 required secondary procedures, 67% returned to their previous level of employment, and the mean Foot Function Index scores were 41 for pain, 37 for disability, and 19 for activity.

Functional outcomes in isolated process or head fractures are somewhat better. Among 20 lateral process fractures with a mean 3.5-year follow-up, the mean AOFAS score was 93, with the score for surgically treated patients (97) higher than that for nonsurgically treated patients (85).[31] All surgically treated patients were able to return to their previous level of sport, as were two of six treated nonsurgically.[31] For talar head fractures, the PROMIS scores at the mean 14.5-month follow-up in 8 surgically treated cases were 42.95 for physical function, 54.57 for pain interference, and 50.84 for disability, all of which are within 1 SD of the population mean.[33]

Summary

The anatomic features of the talus present unique challenges in evaluating and treating fractures. The modern, dual approach method of primary fixation as well as innovative reconstructive and salvage techniques have improved the care of these injuries. Disabling complications remain all too frequent though in higher energy patterns. This provides an imperative for additional research into the prediction, prevention, and treatment of these complications going forward.

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