Hindfoot Dislocations: When Are They Not Benign?

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Abstract

Acute hindfoot dislocations are usually characterized by displacement of both the talocalcaneal and the talonavicular joints. Medial dislocations are more common than lateral ones. Closed reduction is usually obtained easily. When closed attempts fail, surgical exploration and removal of recognized obstacles to reduction are necessary. Associated open wounds necessitate aggressive operative management to prevent infection. Postreduction radiographs should be scrutinized for the presence of associated fractures that require fixation or surgical removal. A short-leg walking cast should be used for 3 to 6 weeks. In rare instances, the tibiotalar joint is also dislocated, which usually necessitates open reduction or, if the injury is open, extruded, and contaminated, talar excision. All hindfoot dislocations result in some stiffening of the hindfoot. Painful degenerative arthrosis sometimes develops after this injury. Factors that predispose to poor outcomes include high-energy mechanisms, the presence of open wounds and fractures, and lateral dislocations. Painful arthrosis that does not respond to conservative treatment can be treated with selective hindfoot arthrodesis.

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Hindfoot dislocations are relatively rare injuries. The outcome depends on the magnitude of the original impact. Low-energy injuries generally respond to early reduction and cast immobilization. High-energy injuries carry a greater risk of infection and substantial chondral and osteochondral damage. Proper initial treatment of these dislocations requires aggressive treatment of open injuries and careful assessment of all involved joints, with early removal or fixation of displaced intra-articular fragments. Late complications, including arthrosis and persistent pain, may necessitate a selective hindfoot arthrodesis to obtain a satisfactory clinical outcome.

Epidemiology and Mechanism of Injury

Hindfoot dislocations are unusual injuries, accounting for approximately 1% of all dislocations.[1] Typically, the talonavicular and talocalcaneal joints are both disrupted as the foot displaces around the relatively stationary talus. The prevailing terminology indicates the type of dislocation by the direction of peritalar foot displacement. Medial dislocations involve medial displacement and rotation of the calcaneus, midfoot, and forefoot around the talus (Fig. 1). Lateral dislocations entail lateral displacement and rotation of the foot around the talus (Fig. 2). Presumably, the strong buttress effect of the lateral malleolus is the principal reason medial dislocations are more common than lateral dislocations, accounting for approximately 80% of reported cases. Predominantly anterior and posterior subtalar displacements have also been reported. A rare variant involves total dislocation of the talus, in which the talus is completely dislocated from the ankle and the subtalar and talonavicular joints.

The mechanisms of injury for these different dislocations have been well described. All involve some degree of peritalar ligamentous disruption. Medial subtalar dislocations are the result of forceful inversion stresses applied to a plantar-flexed foot. In these injuries, the sustentaculum tali is thought to act as a fulcrum for the neck of the talus to pivot around,

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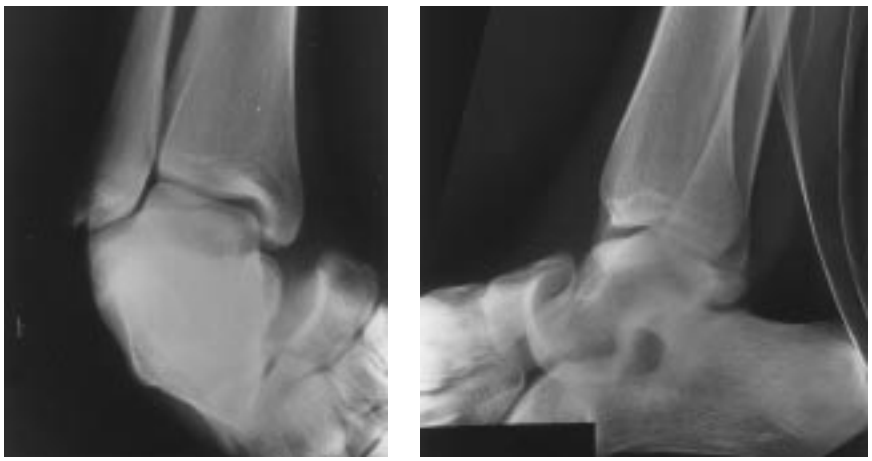

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Fig. 1 Anteroposterior **(A)** and lateral **(B)** radiographs of a medial subtalar dislocation. The articular surfaces of the talus and navicular are completely separated. The talar head appears to rest on the anterior calcaneal process.

sequentially disrupting the talonavicular and subtalar joints.[2] Impaction of the talar head on the navicular may occur with disruption of the talonavicular joint. Lateral subtalar dislocations are thought to result from forceful eversion of a plantar-flexed foot, with the anterior process of the calcaneus acting as a fulcrum around which the anterolateral corner of the talus pivots.[2] Occult fractures of the lateral process of the talus may be associated with these dislocations. The mechanism of injury of total talar dislocations involves a continuation of the forces required for either medial or lateral subtalar dislocation with disruption of the talocrural ligaments and extrusion of the talus from the ankle joint.

Diagnosis

The patient who presents with a hindfoot dislocation typically gives a history of an acute event associated with immediate pain and rapid swelling below the ankle. Visual inspection will reveal gross deformity of the hindfoot and, occasionally, critical skin blanching around a protuberant talar head. With a medial subtalar dislocation, the head of the talus bulges dorsolaterally, and the remainder of the foot is plantar-flexed and supinated. With a lateral subtalar dislocation, the head of the talus protrudes medially, and the remainder of the foot is pronated, with apparent shortening of the lateral border. Neurovascular examination, including a detailed sensory examination of the posterior tibial, saphenous, sural, and deep and superficial peroneal nerves, should be performed at the time of presentation. The circulatory status of the skin about the talar head should also be noted. The physician should be alert for the possibility of compartment syndrome in the foot, particularly if there is an associated fracture.

The initial radiographic evaluation should include anteroposterior and lateral views of the hindfoot and a mortise examination of the ankle. The talonavicular and talocalcaneal joints dislocate together, and the talonavicular joint is easier to evaluate on routine radiographs. The relationship of the head of the talus to the navicular should be

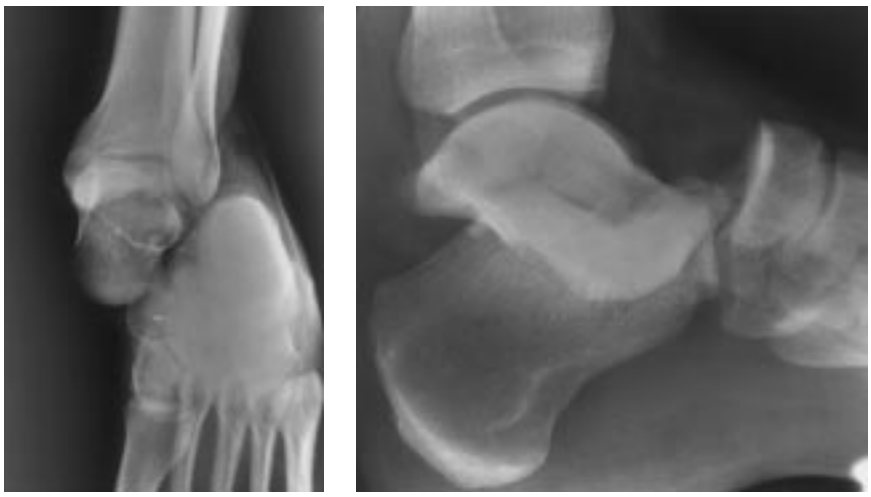

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Fig. 2 Anteroposterior **(A)** and lateral **(B)** views of a lateral subtalar dislocation. Talus appears completely disengaged from its relationship with the calcaneus and the navicular; unimpeded by these restraints, the talus plantar-flexes. Reduction requires longitudinal traction and initial exaggeration of the pronated deformity, followed by slow supination; the surgeon must maintain control of the talar head to feel the talonavicular joint reduce.

congruent in all views of the hindfoot; any incongruity suggests a subluxation or dislocation.

Plain radiographs must be assessed for evidence of associated fractures before and after any reduction maneuvers. With medial dislocations, particular attention should be directed to the dorsomedial talar head, the posterior tubercles of the talus, and the lateral navicular. Lateral dislocations can be associated with fractures of the cuboid, the anterior process of the calcaneus, the lateral process of the talus, and the lateral malleolus. A high degree of suspicion of associated fractures is warranted when evaluating these dislocations. Because the subtalar joint and the periarticular osseous anatomy are difficult to visualize with routine radiography, plain or computed tomography (CT) may be required after reduction (Fig. 3).

Fig. 3 Semicoronal CT scan of a patient with continued pain 2 months after lateral subtalar dislocation. A small intra-articular fragment of the lateral talar process correlated with the location of pain. Simple excision was performed on a delayed basis with satisfactory results.

Management

To avoid the complications of skin or distal foot vascular compromise, an early reduction is recommended for all closed injuries. Reduction should be performed in the emergency room with adequate intravenous sedation. The knee is flexed to relax the gastrocnemius muscle, and an assistant cradles the thigh for countertraction. For a medial dislocation, the reduction maneuver involves initial longitudinal traction and foot hypersupination, followed by pronation and a gentle reduction of the talonavicular joint. The talar head is palpated as it glides into the navicular concavity. For a lateral dislocation, the patient is positioned similarly. The reduction maneuver involves initial traction and foot hyperpronation, followed by supination. As with medial dislocations, the talar head should be felt to smoothly engage the navicular concavity during the reduction procedure. Most routine subtalar dislocations are reduced easily, often with an audible clunk. Postreduction peritalar stability should be tested manually with passive foot pronation and supination.

After reduction, anteroposterior and lateral views of the hindfoot are repeated. The radiographs are assessed for the adequacy of the reduction and the presence of associated fractures. In uncomplicated cases, we then apply a bulky compressive dressing supported by a plaster U splint and ask the patient to maintain limb elevation for 24 to 48 hours.

After the initial swelling has subsided, a short-leg cast is applied, and the patient is allowed to bear weight as tolerated. Other authors have recommended an initial non-weight-bearing period.[3] In most cases, the reduction is stable, and 3 to 4 weeks of immobilization is sufficient. If postreduction instability is suspected, 6 weeks of casting may be more prudent. When the cast is removed, the patient is allowed to ambulate without further restriction.

The presence of periarticular fractures on postreduction radiographs may alter management. Nondisplaced fractures should be treated with immobilization. Large displaced articular fractures of the lateral or posterior process of the talus are amenable to open reduction and internal fixation.[4-6] Smaller osteochondral fractures can be difficult to identify.[3,7] In all cases in which postreduction radiographs demonstrate the possibility of an osteochondral fracture and in all cases of subtalar dislocation due to high-velocity mechanisms (e.g., motor vehicle accidents and falls from heights), the subtalar and talonavicular joints should be imaged with 30-degree semicoronal and transverse CT scans, respectively. If a displaced intra-articular fragment is identified on these imaging studies, we surgically remove it (Fig. 4).

Occasionally, gentle attempts to perform a closed reduction under intravenous sedation fail. In these cases, the patient should be taken to the operating room and given a general or spinal anesthetic. If a subsequent attempt to reduce the injury is unsuccessful, we recommend performing an open reduction. The main impediments to reduction are mostly found near the talar head on the anterolateral aspect of the hindfoot.

With medial dislocations, the talar head can "buttonhole" through the extensor retinaculum or extensor digitorum brevis; can be blocked from reduction by an interposed short extensor muscle, deep peroneal neurovascular bundle, peroneal tendon, or talonavicular

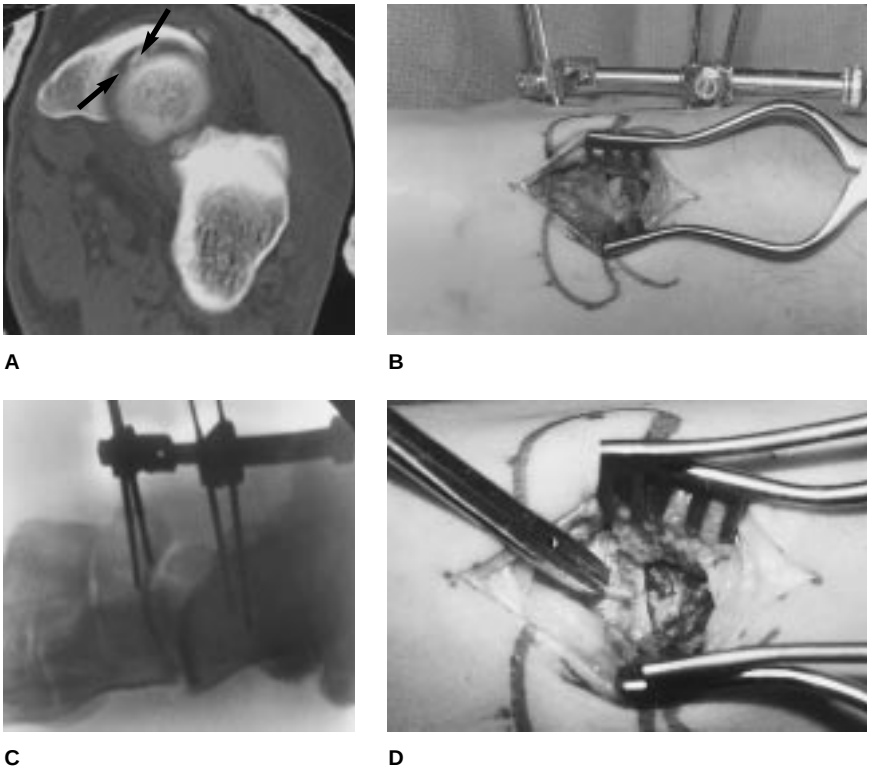

Fig. 4 **A,** Transverse CT scan of a foot immediately after closed reduction of a medial subtalar dislocation. Arrows indicate osteochondral fragments in the talonavicular joint. Operative removal of the fragments was recommended. **B,** Intraoperative photograph with the talonavicular joint exposed. A small external distractor was used to gain access to the joint. **C,** Intraoperative fluoroscopic radiograph demonstrates the use of the small distractor to aid exploration of the talonavicular joint. **D,** Close-up photograph shows removal of talonavicular joint fragments. In this case, as is generally true with medial subtalar joint dislocations, the osteochondral fragments came from the dorsal talus rather than the relatively harder navicular bone.

joint capsule; or can become impacted on a sharp border of the navicular.[8,9] The best surgical approach for identifying and eliminating the obstacles to reduction of a medial dislocation is through a longitudinal incision over the talar head.

Irreducible lateral dislocations can be caused by superolateral displacement of the posterior tibial or flexor digitorum longus tendons onto the lateral neck of the talus or by impaction fractures around the talar head.[3,10] The surgical approach is directed at the pathologic condition. If associated fractures are identified, an incision is placed to visualize the obstacle to reduction. If no fractures are seen on preoperative radiographs, a longitudinal incision from the medial malleolus over the talar head will give access to the extrinsic flexor tendons and the talonavicular joint.

The surgeon may find other unusual blocks to reduction of hindfoot dislocations. A high index of suspicion of an associated fracture or occult soft-tissue interposition should be maintained when reasonable attempts to reduce hindfoot dislocations fail. We treated one patient with a chronic cuboid dislocation that reduced only after the peroneus longus tendon was rerouted from the dorsum of the cuboid to its natural plantar location.

Open dislocations should be treated on an emergent basis in the operating room with aggressive wound irrigation and debridement (Fig. 5). The intrinsically tenuous blood supply of the talus heightens the risk of chronic infection with major open injuries. Adequate visualization and debridement are possible only in the operating room with the use of general or regional anesthesia. Traumatic wounds are generously extended proximally and distally; interposed soft tissue is identified and retracted; and the wounds are completely debrided and irrigated before reduction.

The reduction maneuvers are the same as for closed reductions except that with open injuries, the surgeon often has an opportunity to directly visualize reduction of the talonavicular joint. Wounds should be debrided again after reduction. Surgical wound extensions are closed, but traumatic wounds are left open. Systemic antibiotics should be utilized as in standard open-fracture protocols. Repeat irrigation and debridement and secondary wound closure should then be performed in the operating room 48 to 72 hours later. In rare high-grade cases, early tensionless coverage may necessitate free-tissue transfer.

Total dislocations of the talus always present a serious management challenge. As over 60% of the surface of the talus is articular and has no muscular attachments, the bone is especially susceptible to circulatory disruption. Most total talar dislocations leave few or no soft-tissue attachments to the bone. Moreover, the majority of the reported cases of total dislocations of the talus have been open.[11-14]

Fig. 5 An open lateral subtalar dislocation with a 10-cm transverse medial wound. The head and neck of the talus are protruding through the wound.

The talus is often partially or totally extruded through the skin.

Closed total dislocations require urgent reduction to prevent skin necrosis.[15] A general or spinal anesthetic is almost always necessary. Reduction requires strong longitudinal traction. The use of pins in the calcaneus and the tibia can be helpful. If initial attempts to perform a closed reduction fail, an open reduction, as described for subtalar dislocations, is performed. When the talus is displaced posteromedially, care should be taken to protect the neurovascular bundle, which may be tightly tented around the talus.

Postoperatively, the leg is immobilized in a short-leg nonwalking cast for 6 weeks, followed by use of a short-leg walking cast for 4 weeks. Severe postreduction instability may necessitate transarticular Kirschner-wire fixation or external fixation. Patients are then followed up on a long-term basis for the development of talar collapse or arthritis in the contiguous joints.

Open injuries are at high risk for the development of deep infection.[12-14] An aggressive approach involving early irrigation and debridement is necessary to obtain satisfactory long-term results. Injuries that have completely devascularized an extruded talus, those that are grossly contaminated, and those for which irrigation and debridement are excessively delayed are particularly troubling. In these cases, we recommend talar excision to decrease the chances of infection.[13] The patient can be left with a talectomy or can be treated with tibiocalcaneal fusion. Talectomy preserves limited motion, but there is a chance of pain and varus deformity. If tibiocalcaneal fusion is chosen, length can be preserved by techniques such as distraction osteogenesis at a proximal level.

Results and Complications

Hindfoot dislocations are not all benign. The ease of reduction, the stability after reduction, and postreduction immobilization in a simple short-leg cast may lead both the surgeon and the patient to believe that the prognosis is uniformly excellent. Unfortunately, this is not true. Although some patients rapidly return to full function and report little or no pain, most will have some loss of motion, and a subgroup will have both pain and functional impairment.[3,5,16,17]

Stiffness of the hindfoot is the most common impairment seen after subtalar dislocation. If examined carefully, most patients are seen to have loss of subtalar motion.[17-19] Although loss of motion in and of itself does not lead to marked disability, it is still tempting to encourage early motion after reduction to decrease late stiffness.[3,17] However, this temptation must be balanced against the possible occurrence of instability, which is less frequent than stiffness but potentially a greater problem for the patient. Many authors do not report instability as a problem after subtalar dislocation, but Zimmer and Johnson[20] found that five of their eight patients complained of instability. They conjectured that instability may be more common than generally recognized. Recurrent dislocation has also been reported to occur within weeks of the initial dislocation.[21] Therefore, we believe that the duration of immobilization should be individualized according to the severity of the injury and the degree of intrinsic stability after reduction.

Several factors present at the time of the initial injury are predictive of the likelihood of poor results. These factors include high-energy mechanisms, such as motor vehicle accidents and falls from heights; open wounds; and fractures in the region of the subtalar joint.[3,5,16] These factors often occur together, and poor results are frequent. In one series in which 41% of the dislocations were open and 64% had associated fractures, there were 72% fair or poor results.[6] Lateral dislocations are less frequent, require more energy, are commonly associated with fractures, and have a less favorable prognosis.[3,17,19] Surgeons should be aware of these predictors for poor outcome and should counsel their patients accordingly.

There are some factors within the surgeon's control that may improve the prognosis in high-risk cases. Open wounds, which have been reported to occur in as many as 40% of hindfoot dislocations, must be managed very aggressively because they present a serious risk of infection, which should be prevented if at all possible. Edmunds et al[16] found that infection developed in 30% of the open dislocations in their study, and Marsh et al[13] demonstrated that in-

fection in an open hindfoot fracture-dislocation has a major negative impact on patient outcome. The risk of infection is high because there is no muscle cover, the vascularity of the soft tissues in the area is poor, and contaminated joints are difficult to cleanse adequately.

In open total dislocations of the talus, the entire talus may be extruded either medially or anterolaterally. In these devastating injuries, talar dysvascularity, soft-tissue injury, and contamination of both the bone and the joint spaces lead to a high risk of infection when the talus is preserved. Detenbeck and Kelly[14] reported infection in eight of nine cases, and in a mixed series of dislocations and fracture-dislocations, Marsh et al[13] reported a 38% infection rate. In these cases, primary talar excision may offer the best chance to avoid infection.

Degenerative arthritis is common after subtalar dislocation and is the single most important cause of long-term pain and disability.[3,5] The incidence of arthrosis may be even higher than reported because it is difficult to establish the diagnosis of arthrosis on plain radiographs. The subtalar joint is prone to arthrosis after dislocation, particularly in high-energy dislocations, because as the calcaneus slides past the talus during dislocation, compressive and shearing forces result in cartilage injury.

Arthrosis is frequently associated with fracture.[3,6] Treatment of fractures by reduction and fixation may decrease the incidence and severity of arthrosis. Although there are insufficient data in the literature to determine whether surgical removal of small osteochondral fragments decreases the incidence of arthrosis, it is our preference to look for and remove these fragments.

Not all patients with arthrosis are symptomatic. Some present with mild or intermittent activity-related pain. They often state that their discomfort reaches a crescendo as the working day proceeds and that their symptoms are particularly exacerbated by walking across uneven ground. These patients may benefit from the intermittent use of nonsteroidal anti-inflammatory agents and from orthotic immobilization of the hindfoot joint. To control subtalar and transverse tarsal motion, the orthotic must be molded to cup the calcaneus and fit intimately into the medial longitudinal arch. An orthotic fabricated from a polypropylene shell and a moldable-foam liner generally provides comfortable immobilization of the affected joints.

If a reasonable trial of conservative treatment for hindfoot arthrosis has failed, the patient may be a candidate for a selective hindfoot arthrodesis. Although the subtalar joint is most commonly involved, it is absolutely critical to identify all the painful joints before performing a hindfoot arthrodesis. When the exact source of pain is confusing, a fluoroscopically controlled anesthetic injection is used to identify joints suspected of being related to the patient's symptoms (Fig. 6, A). Contrast dye is instilled to confirm the location of the anesthetic. Before each injection, the patient is encouraged to walk vigorously to provoke the symptoms, and after each joint injection, this activity is repeated; the level of pain relief is thus sequentially assessed. We have found a high correlation between the level of pain relief and the results of selective hindfoot arthrodesis.[22] Selective fusions of the subtalar or talonavicular joints are performed in situ with use of a single large partially threaded cannulated screw (Fig. 6, B).

Necrosis of the talar body is not a common complication of routine subtalar dislocation.[3,5] Talar-neck fractures with associated subtalar dislocation have been reported to have a high incidence of talar-body necrosis, but when a neck fracture is not present, the displacement of the dislocation itself only rarely leads to talar-body necrosis. The incidence of necrosis is higher in a total dislocation of the talus than in a routine subtalar dislocation. Necrosis may not be symptomatic enough to require treatment.

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Fig. 6 **A,** Fluoroscopically controlled anesthetic injection of the subtalar joint. The patient reported complete pain relief after the injection. **B,** A lateral radiograph demonstrates osseous union 1 year after a subtalar arthrodesis. The patient had excellent pain relief.

Summary

A broad spectrum of injuries have been classified as acute hindfoot or peritalar dislocations, and the prognosis varies considerably according to causation and severity. At one end of this spectrum are simple inversion dislocations due to relatively low-energy trauma, such as may occur while playing basketball. These are easily reduced and are stable after reduction. After brief immobilization, they have an excellent prognosis for long-term function. At follow-up, patients complain of little pain and rarely require late procedures. The worst problem is mild stiffening of the hindfoot.

At the other end of the spectrum are hindfoot dislocations sustained in high-speed injuries from motor vehicle accidents or falls from heights. In such injuries, dislocation occurs laterally as often as medially, and there are frequently associated open wounds and fractures. The combination of these factors with occult cartilage injury leads to a substantial incidence of pain, disability, subtalar arthrosis, and other complications that require late treatment. Complications can be minimized by diagnosis and treatment of associated fractures and aggressive treatment of open wounds. If arthrosis leads to pain and disability, subtalar arthrodesis should be considered.

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