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Talus fractures: open reduction and internal fixation

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Introduction

Talus fractures are not only rare, but also difficult to treat. The majority of fractures occur at the neck of the talus. Fractures of the body and of the head are less common. Because 60% of the surface of the talus is covered by articular cartilage and no tendons or muscles attach to it, there are only a few sites where feeding arteries can enter. The feeding artery along the interosseous talocalcaneal ligament is damaged in fracture-dislocations of the neck of the talus, and aseptic necrosis of the body tends to occur. If aseptic necrosis develops, the trochlear portion of the talus collapses under the weight of the body, and degenerative arthrosis develops at the ankle joint and the subtalar joint, with pain and limitation of range of motion as sequelae. Since articular surface incongruity and contracture also cause degenerative arthrosis, anatomical reduction and rigid internal fixation, which allow early postoperative motion, are essential. Even though the anterior and middle subtalar joints and the posterior subtalar joint curve in opposite directions and are separated by the tarsal canal, they have a common axis of rotation, and from a functional standpoint are regarded as a single joint. Thus, while fractures of the neck of the talus pass through the talar canal and are extra-articular, they require the same anatomical reduction as intra-articular fractures.

Even though the diagnosis is usually evident on plain radiographs, computed tomography in the axial and frontal planes is often helpful for the classification of the fracture and the choice of treatment.

Classification

Fracture-dislocations of the neck of the talus are most common and have been classified according to the displacement of the fracture fragments [Hawkins 1970]. This classification is of value in particular with regard to the incidence of aseptic necrosis. Type 1 injuries are nondisplaced fractures of the talar neck, which may be impacted and quite stable. In type 2 injuries, the posterior subtalar joint is subluxed or dislocated. The talocalcaneal ligaments are disrupted, which impedes anatomic reduction of the fracture. In type 3 injuries, there is additional dislocation of the ankle joint. A large percentage of type 3 fractures are open injuries. In type 4 injuries, the talonavicular joint is also dislocated [Canale and Kelly 1978].

Talar body fractures are less common. They may be classified as osteochondral lesions, shear fractures of the body of the talus, posterior process fractures, lateral tubercle fractures and crush injuries of the talar body [Sneppen et al. 1977]. Fractures of the head of the talus are also uncommon. They occur as impacted compression fractures or as sagittal or oblique fractures, which usually involve the talonavicular joint.

Treatment

Indications for surgery

Type 1 fractures of the talar neck are generally treated conservatively [Dunn et al. 1966]. Type 2 and other fracture-dislocations of the talar neck are indications for surgery [Szyszkowitz et al. 1985, DeLee 1992]. Immediate reduction may be required if there is significant displacement, compromising the surrounding soft tissues and neurovascular structures. Subtalar subluxation sometimes reduces naturally, but it may be associated with comminuted bone fragments in the talar canal and require surgery.

Osteochondral lesions of the talar body are usually reattached by arthroscopy [Beck 1991]. The remaining talar body fractures are treated according to the same principles as talar neck fractures. Owing to the involvement of the ankle and the subtalar joint, open reduction and internal fixation should be used whenever there is any displacement of the fracture fragments. Talar head fractures should also be anatomically reduced and stabilized, if there is any significant displacement and if the talonavicular joint is involved. Alternatively, small fracture fragments may be excised.

Surgical technique

The patient is placed in the supine position and a pneumatic thigh tourniquet is applied. The hip joint is flexed and externally rotated, the knee slightly flexed, and the medial malleolus of the ankle joint is turned so that it faces up. Surgery is performed under general or spinal anaesthesia.

Surgical approach

The skin is incised from the tuberosity of the navicular bone over the tip of the medial malleolus to the posterior margin of the tibia (Figure 1). If osteotomy of the medial malleolus is not necessary (see below), the skin incision is stopped at the tip of the medial malleolus. Caution is required to avoid injuring the saphenous nerve, great saphenous vein and the tibialis posterior tendon when making the incision. If the descending branch of the greater saphenous vein impedes exposure of the subcutaneous tissue, it is ligated and sectioned.

In type 3 or 4 fracture-dislocations of the neck and fracture-dislocations of the body it may be necessary to perform an osteotomy of the medial malleolus, to ensure an adequate exposure of the surgical field. The flexor tendon retinaculum is opened and the tibialis posterior muscle is displaced, the anterior margin and the posterior margin of the base of the medial malleolus are exposed through small capsular incisions (Figure 2), and the angle between the roof of the ankle joint and the articular surface of the medial malleolus is palpated with a narrow periosteal elevator. Next, a 3.2 mm hole is drilled in the tip of the medial malleolus parallel to its articular surface, in order to reattach the medial malleolus after the procedure. The position of the osteotomy is marked on the surface of the medial malleolus. The osteotomy of the medial malleolus is performed with the bone saw, pointing slightly distally towards the angle of the medial side of the ankle articular surface, at a right angle to the drill hole. The medial malleolus is then reflected distally with the deltoid ligament serving as the fulcrum, and a nylon suture is passed through the bone hole as a landmark. The fracture surface in the talus, the articular surface of the tibia and of the lateral malleolus, and the posteriorly displaced body of the talus can be visualized (Figure 3).

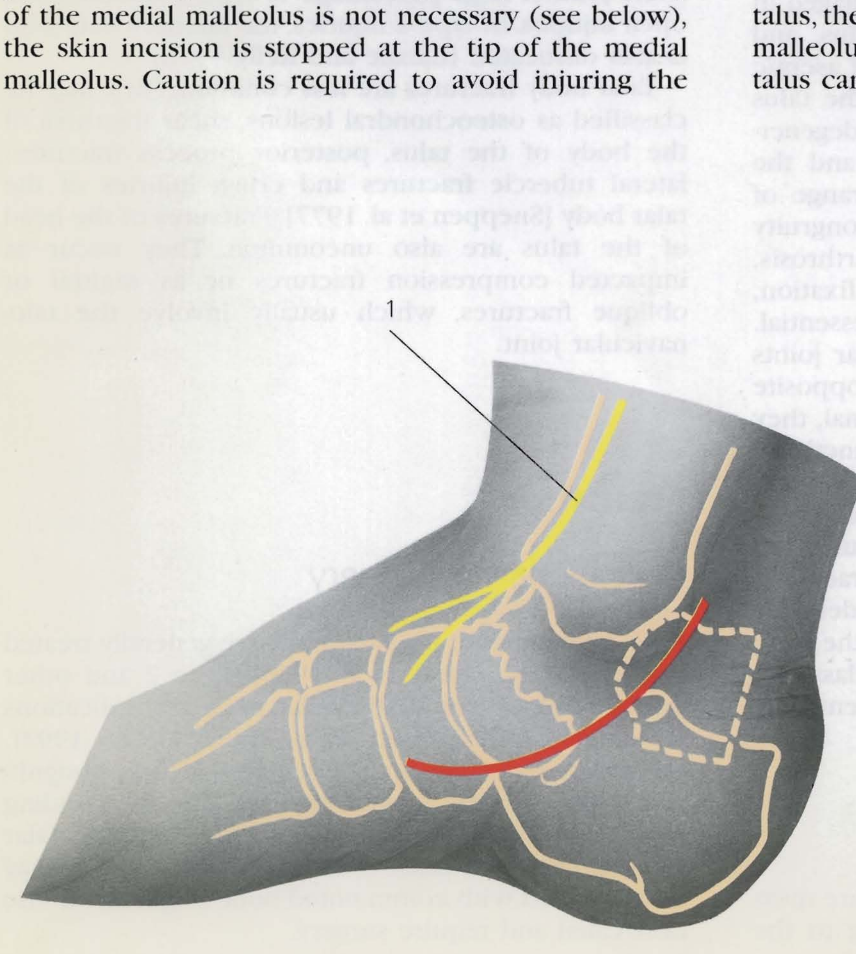


Figure 1

The skin incision reaches from the tuberosity of the navicular bone to behind the medial malleolus

1 Saphenous nerve

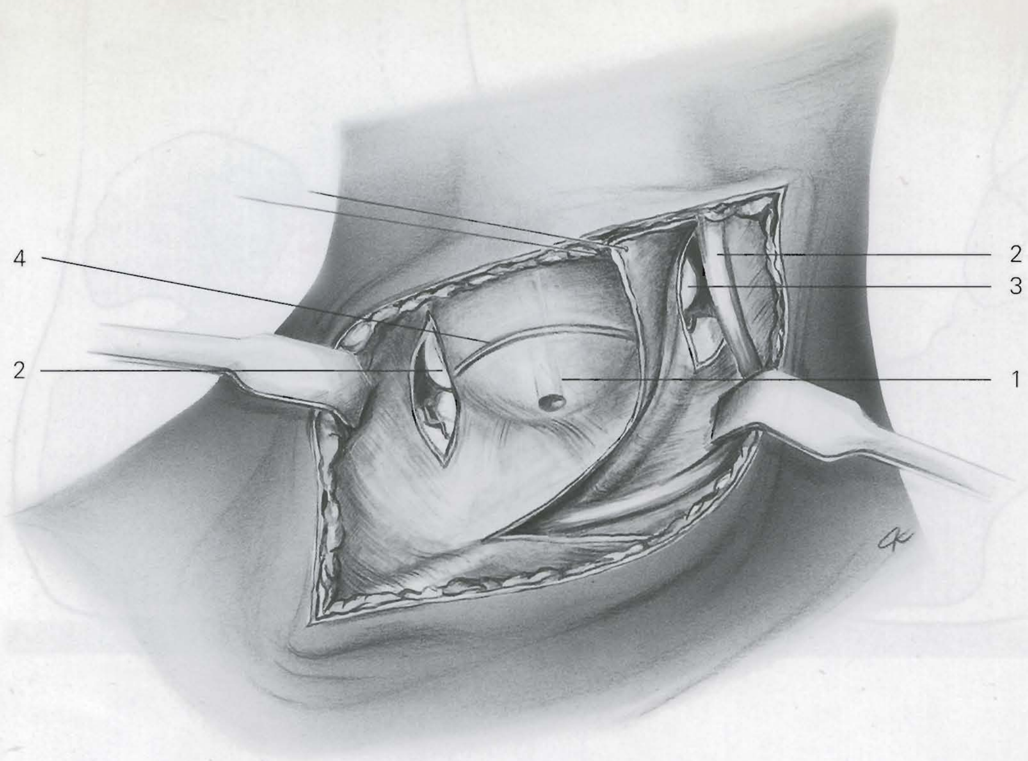


Figure 2

If an osteotomy of the medial malleolus is needed for exposure, the skin incisions are mobilized, small incisions are made in the joint capsule and the anterior and posterior margins are dissected through small incisions. A drill hole is made in the tip of the medial malleolus parallel to its articular surface. The flexor tendon retinaculum is opened, and the tibialis posterior tendon is retracted posteriorly

1 Drill hole in medial malleolus
2 Anterior and posterior margins of tibia
3 Posterior tibial tendon
4 Osteotomy

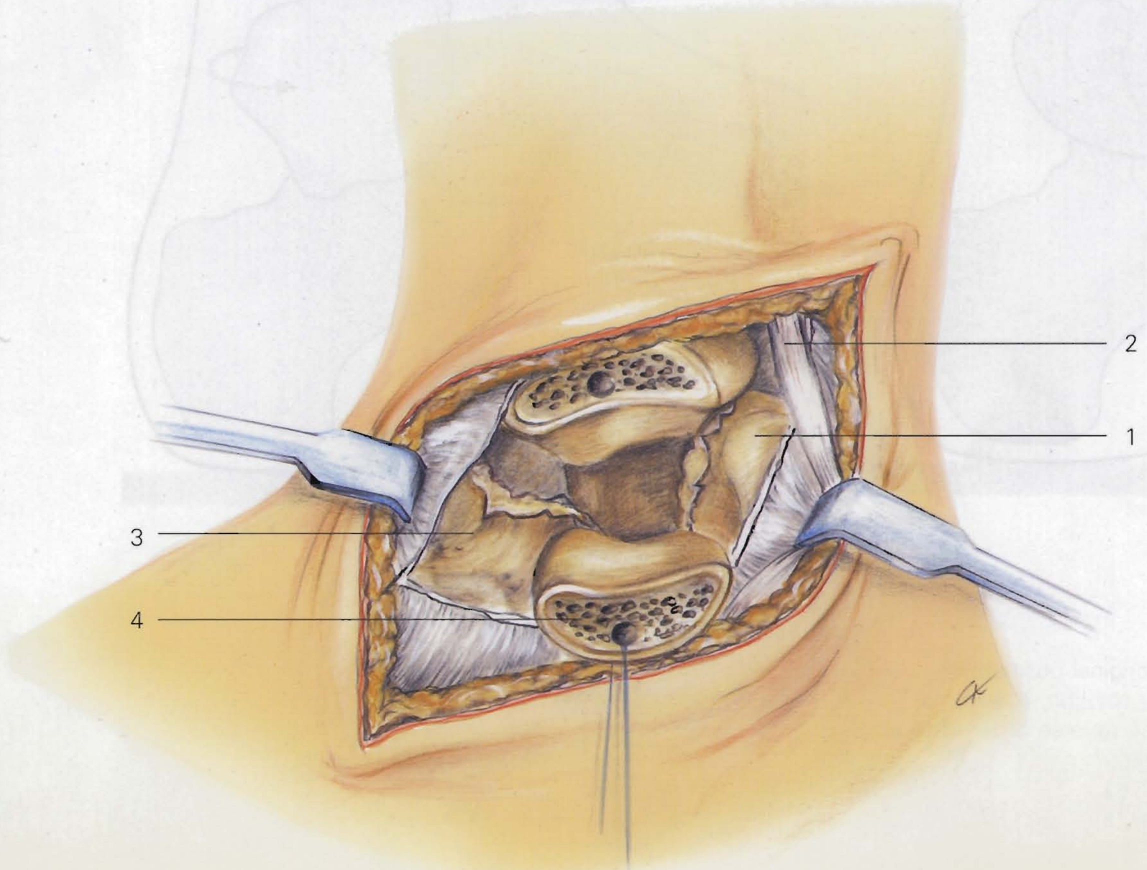


Figure 3

Following osteotomy of the medial malleolus, the talus fracture and the ankle joint space are exposed

1 Talar body fragment
2 Posterior tibial tendon
3 Talar neck fragment
4 Medial malleolus

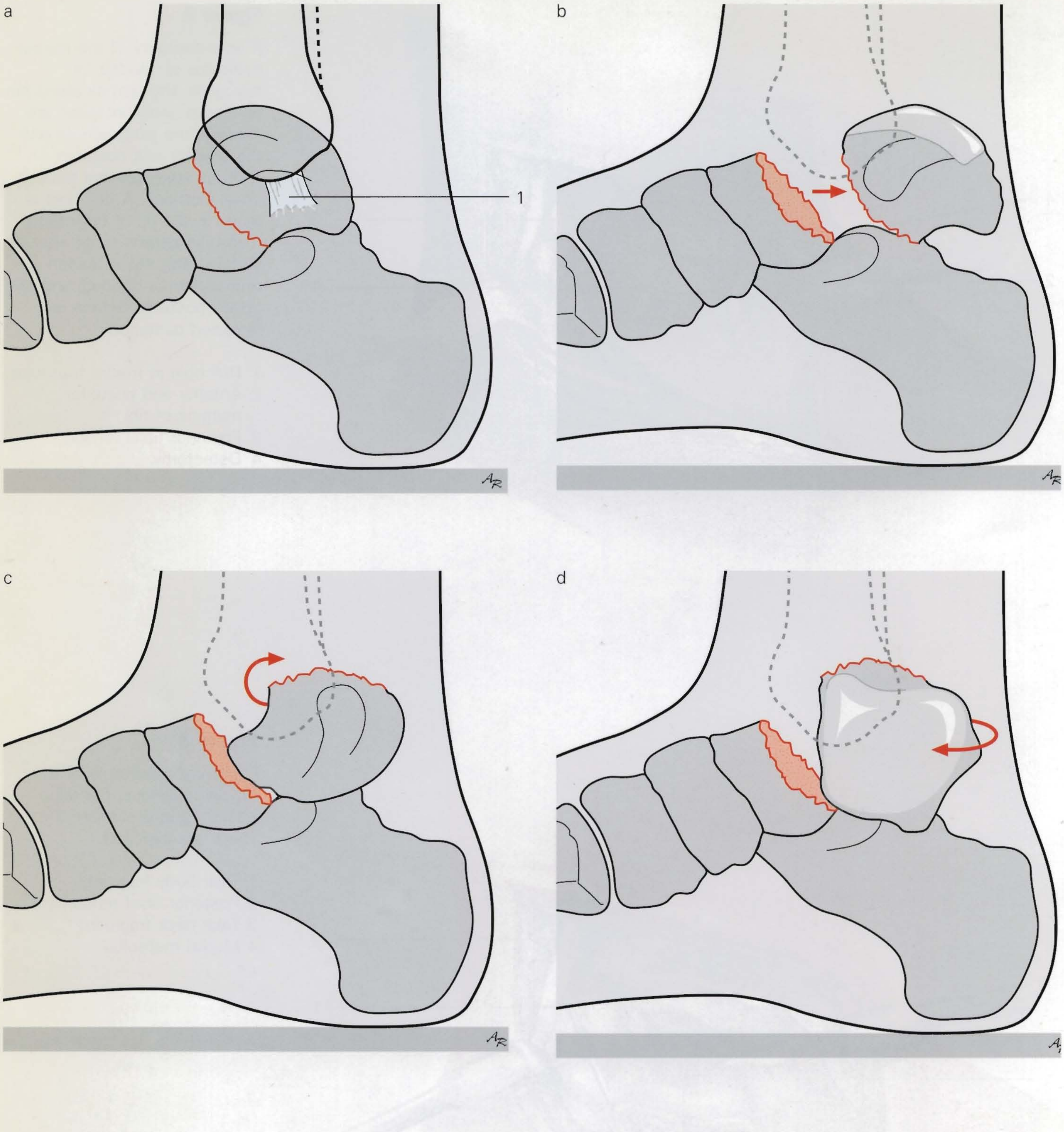


Figure 4

Dislocation of the body fragment. a. original position; b. posterior displacement; c. posterior rotation; d. external rotation. Reduction is performed in the reverse order (d to a)

1 Deltoid ligament

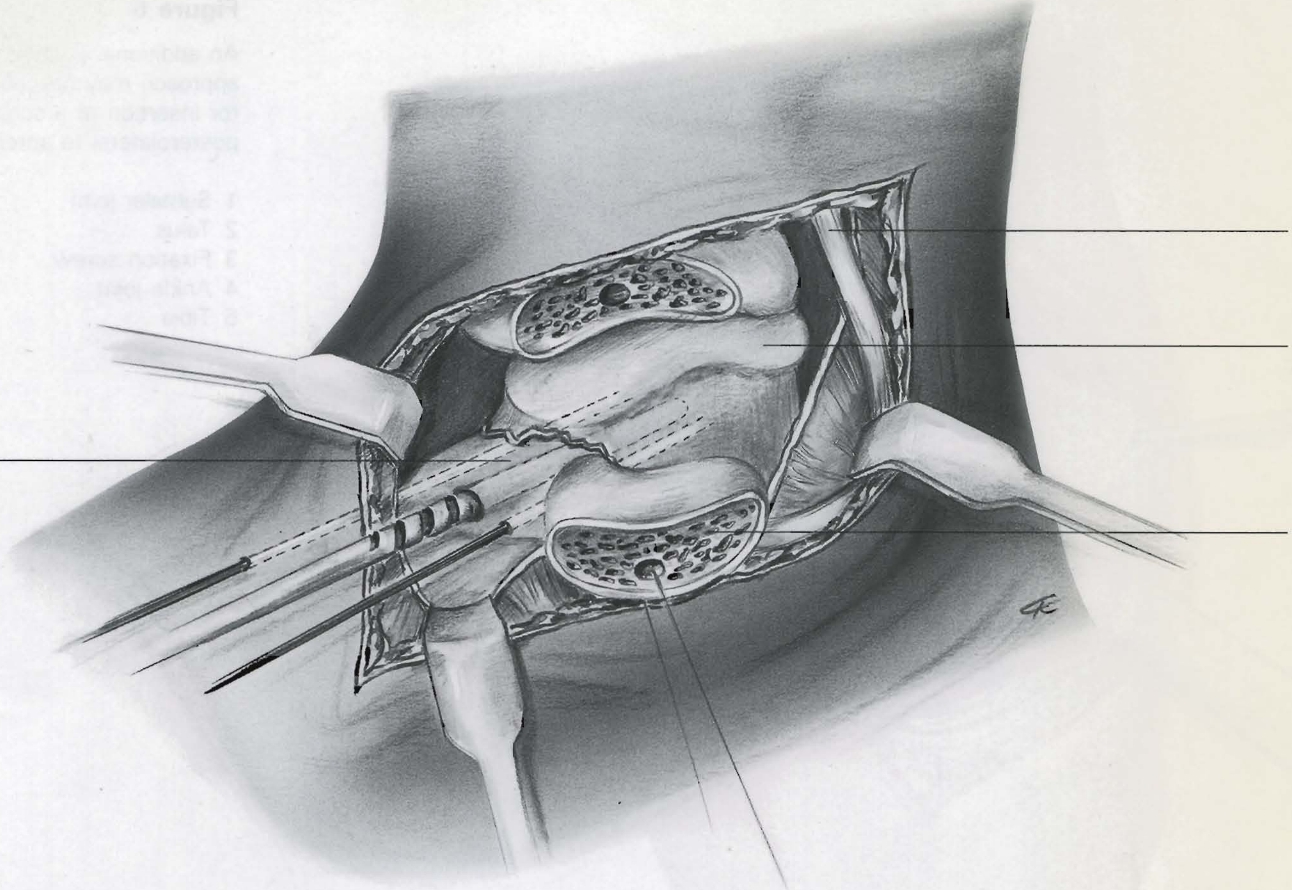


Figure 5

Following reduction of the fracture, two Kirschner wires are used for temporary fixation. After confirming the reduction radiographically, a 3.2 mm drill hole is made from the dorsal side of the neck towards the posterior process

1 Medial malleolus
2 Posterior tibial tendon
3 Talar body fragment
4 Talar neck fragment

Reduction

With the deltoid ligament as the fulcrum, the fragment of the talar body is displaced from the ankle joint space posteriorly and rotated posteriorly and externally. The fracture surface is turned so that it faces superiorly and the trochlear surface so that it faces medially. The body fragment is often positioned posterior to the medial malleolus and superomedial to the tuberosity of the calcaneus (Figure 4).

Reduction is performed in the reverse order, by internal and anterior rotation with the deltoid ligament as the fulcrum. The ankle is plantar flexed to relax the flexor tendons. With the trochlea facing up, the area between the Achilles tendon and the tibia is pushed in. The ankle joint is dorsiflexed while pulling the calcaneus inferiorly and pushing the fragment of the body anteriorly in the direction of the ankle joint space. If it is difficult to grasp the calcaneus during reduction, traction can be exerted on the tuber calcanei with a Kirschner wire. During this manœuvre, care is taken not to injure the remaining deltoid ligament and the blood vessels feeding the body of the talus, which course along it [Pennal 1963]. The deltoid ligament, which is attached to the fragment of the body, must never be severed even if reduction is difficult.

This manœuvre is followed by thorough examination of the fracture and irrigation, and by removal of clotted blood and small bone fragments that might

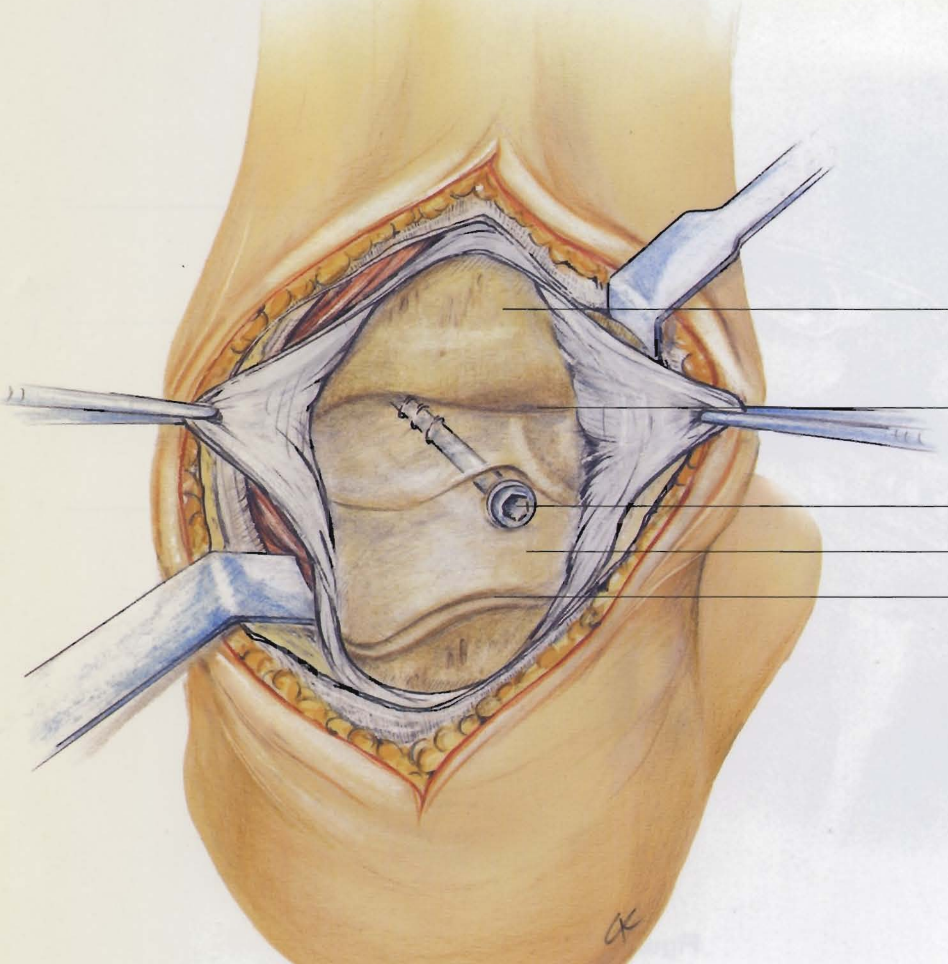


Figure 6

An additional posterolateral approach may be necessary for insertion of a screw from posterolateral to anteromedial

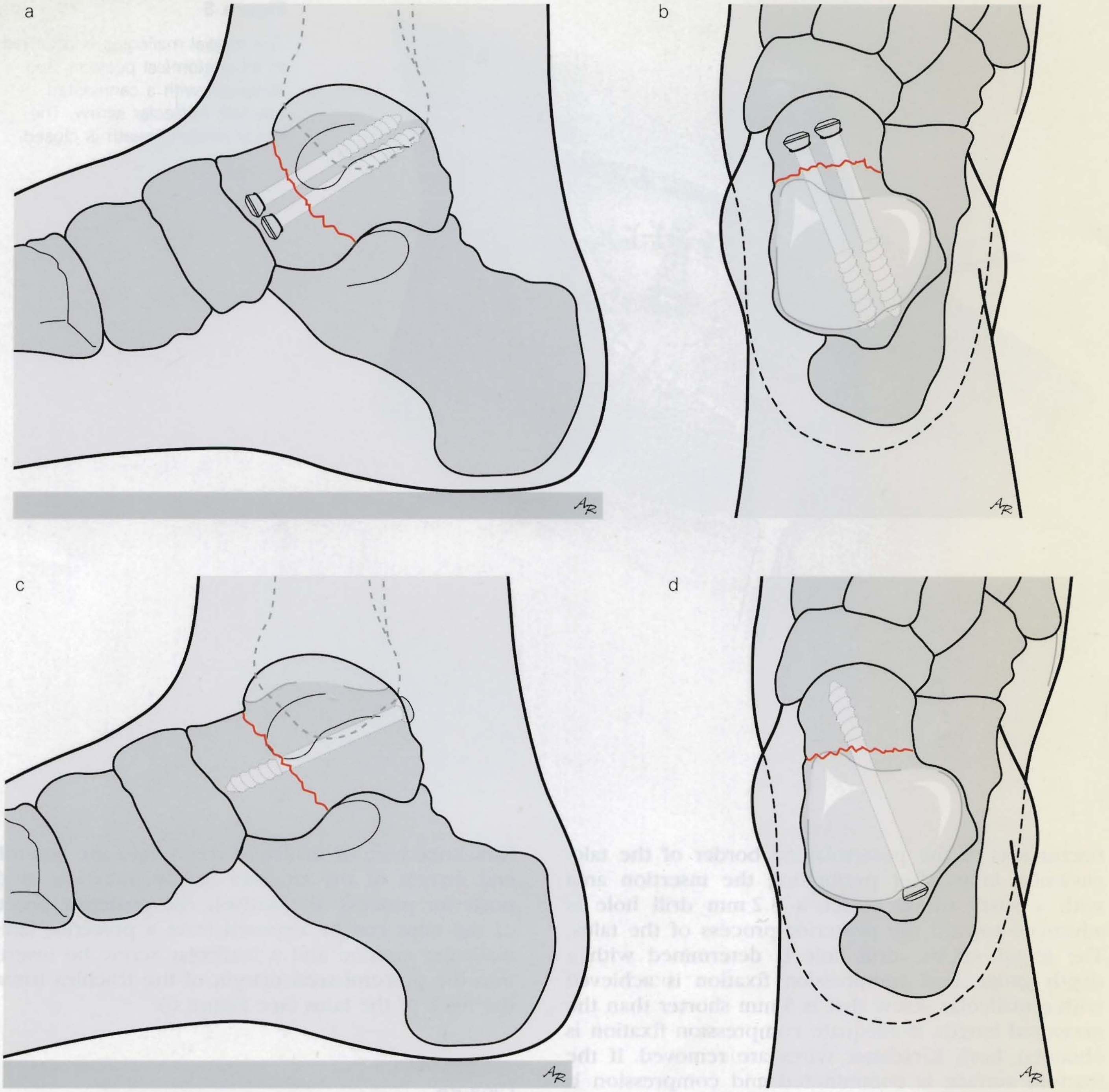
1 Subtalar joint
2 Talus
3 Fixation screw
4 Ankle joint
5 Tibia

impede reduction. The Achilles tendon, the tibialis posterior tendon, the flexor digitorum longus tendon and the flexor hallucis longus tendon may block the bone fragments in the body of the talus and interfere with reduction. In this case, the tibialis posterior tendon is detached from its insertion at the navicular bone with a bone fragment attached, and the other flexor tendons are sectioned in a Z-shaped fashion.

When the body of the talus has been repositioned in the ankle joint, the fracture surfaces are reduced anatomically. Because there are few anatomic landmarks to verify the reduction of neck fractures, it is easy to leave the talus in rotation deformity. However, when the fracture line passes through the anteromedial aspect of the trochlea, this serves as a good indicator for reduction. If the talus fracture is comminuted and complete reduction is uncertain, congruence can be achieved at the ankle joint and the posterior subtalar joint surfaces by pronation and supination of the subtalar joint while simultaneously pressing on the body of the talus and the calcaneus through the sole of the foot. In type 4 lesions, only the alignment of fracture surfaces can be used as an indicator for reduction, because the head of the talus is dislocated as well.

Internal fixation

Following reduction, the fracture should be temporarily stabilized with two 1.5 mm Kirschner wires (Figure 5). One wire is inserted so that it passes from the anterior portion of the navicular bone through the talonavicular joint toward the posterior margin of the lateral malleolus. The other wire is inserted at the superomedial aspect of the talonavicular joint and directed toward a slightly more medial position in the posterior process of the talus. At times, an additional posterolateral incision must be made (Figure 6) and a



Kirschner wire inserted into the talus from posterolateral to anteromedial. The ankle joint and the subtalar joint are moved passively at this point to reconfirm reduction. Once reduction appears to be adequate, this is confirmed by intraoperative radiographs in two planes. If a cannulated malleolar screw is used, radiography is performed following insertion of the guide wires.

Stainless steel malleolar screws or cannulated titanium malleolar screws are used for internal fixation (Figure 7). The site of insertion in talar neck

Figure 7

Compression fixation is generally achieved with cannulated titanium malleolar screws. a. screw placement from anteromedial to posterolateral, medial aspect; b. superior aspect; c. screw placement from posterolateral to anteromedial, medial aspect; d. superior aspect

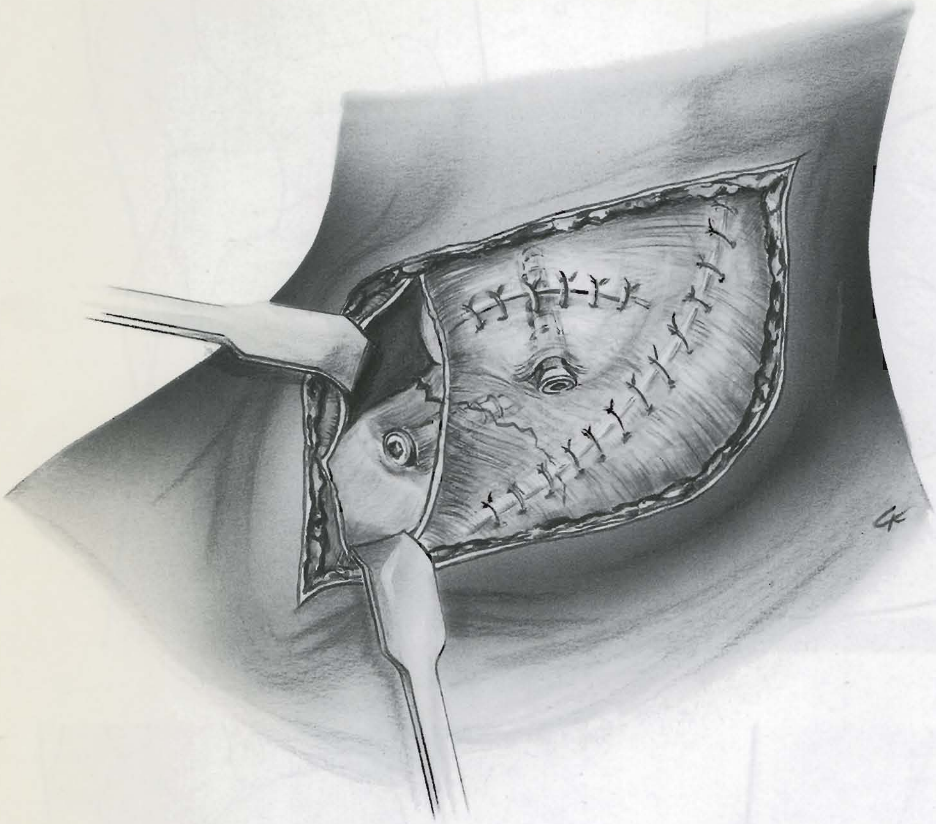


Figure 8

The medial malleolus is returned to its anatomical position, and stabilized with a cannulated titanium malleolar screw. The flexor tendon sheath is closed

fractures is at the posterolateral border of the talonavicular joint. After perforating the insertion area with a small round chisel, a 3.2 mm drill hole is advanced toward the posterior process of the talus. The length of the drill hole is determined with a depth gauge, and compression fixation is achieved with a malleolar screw that is 5 mm shorter than the measured length. If adequate compression fixation is obtained, both Kirschner wires are removed. If the fracture surface is comminuted and compression is not optimal, a second screw is inserted from anteromedial or from posterolateral, or the Kirschner wire inserted into the neck of the talus may be left in place to prevent rotation.

In talar neck fractures, the break occurs in a perpendicular plane to the long axis of the neck of the talus. In talar body fractures the break occurs in a perpendicular plane to the long axis of the trochlea. In talar body fractures, the screw is inserted more lateral to medial, i.e. along the long axis of the trochlea, compared with screw placement in neck fractures. More rigid fixation can be achieved by making a small incision on the lateral aspect of the ankle joint anterior to the lateral malleolus and inserting another Kirschner wire or malleolar screw into the anterolateral margin of the trochlea in the direction of the posterior process. Alternatively, the posterior process of the talus can be exposed from a posterior lateral malleolar incision and a malleolar screw be inserted into the posterolateral margin of the trochlea toward the neck of the talus (see Figure 6).

Closure

Thorough irrigation is performed so that no bone fragments are left within the joint space. The reflected medial malleolus is returned to its anatomical position and the previously drilled hole is used to fix it with a malleolar screw (Figure 8). If sufficient pressure cannot be achieved, an additional Kirschner wire is inserted parallel to the screw, to prevent rotation. If the tibialis posterior tendon has been detached from the navicular, it is reattached through a drill hole. If tendons were sectioned, they are repaired. After returning the flexor tendons to their anatomical position, the flexor tendon retinaculum is closed loosely.

The tourniquet is released. After adequate haemostasis, the subcutaneous tissue and the skin are sutured. A padded plaster splint is applied and wrapped with an elastic bandage, providing compression.

Postoperative care

If postoperative magnetic resonance imaging (MRI) is available, cannulated titanium malleolar screws alone should be used for internal fixation. An MRI examination is performed in the early postoperative period, and the images are checked for low-signal areas that suggest aseptic necrosis of the talus. If none can be found, aseptic necrosis is unlikely. If a low-signal area is present, the patient is followed by both conventional radiography and MRI for early detection of aseptic necrosis.

If rigid internal fixation was achieved, active ankle joint motion is started 1 week after surgery. If fixation is inadequate, motion is started 3 weeks postoperatively. Frontal radiographs of the ankle joint are taken from 3-6 weeks after surgery. The absence of subchondral bone atrophy of the trochlear articular surface of the talus in spite of subchondral bone atrophy at the distal end of the tibia suggests aseptic necrosis [Hawkins 1970]. If subchondral bone atrophy at the trochlea is present, and if bone union is confirmed on radiographs 9-12 weeks after the operation, partial weight-bearing is started, and full weight-bearing is permitted 3 weeks later. Active motion without weight-bearing is continued during this period.

If subchondral bone atrophy has not occurred even 12 weeks postoperatively, and if sclerosis in the trochlear area of the talus is observed, a diagnosis of aseptic necrosis of the body of the talus is made. A weight-relieving appliance is prepared, and nonweight-bearing motion of the ankle joint is continued while awaiting resumption of perfusion to the talus. This is confirmed by the bone atrophy shadow expanding from the attachment site of the deltoid ligament, the lateral process, the posterior tubercle or the fracture site. The strength of the body of the talus is lowest at the time when circulation resumes, and it tends to collapse. Therefore, careful monitoring is required during this period. Blood flow may resume up to 3 years after the injury.

Complications

Aseptic necrosis of the talus is the most common complication following talus fractures [Gillquist et al. 1974]. Its frequency ranges from 10% in type 1 talar neck fractures to 70% in severely displaced fractures of the neck or the body. The incidence is related to the severity of fracture displacement, to the amount of soft tissue dissection during surgery and to the time between injury and reduction. Aseptic necrosis may result in segmental or total collapse of the talar dome, or it may revascularize over a period as long as 2-3 years. If the body of the talus collapses, it is resected and a fusion of the tibia to the distal portion of the talar neck [Blair 1943] or arthrodesis between the tibia and calcaneus is performed. Malunion may occur if inadequate reduction of the fracture is accepted. Degenerative arthrosis of the ankle joint or the subtalar joint may ensue if anatomic reduction of the joint surfaces was not achieved. Nonunion is an uncommon complication, but bone healing may be delayed for 6-12 months after the injury.

References

Beck E (1991) Fractures of the talus. *Orthopäde* **20**: 33–42

Blair HC (1943) Comminuted fractures and fracture dislocations of the body of the astralgus. *Am J Surg* **59**: 37–43

Canale ST, Kelly FB (1978) Fractures of the neck of the talus. *J Bone Joint Surg* **60A**: 143–156

DeLee JC (1992) Fractures and dislocations of the foot. In: Mann RA, Coughlin MJ (eds) *Surgery of the Foot and Ankle.* St Louis, Mosby, pp 1539–1600

Dunn AR, Jacobs B, Campbell RD (1966) Fractures of the talus. *J Trauma* **6**: 443–468

Gillquist J, Oretorp N, Stenstrom A et al. (1974) Late results after vertical fracture of the talus. *Injury* **6**: 173–179

Hawkins LG (1970) Fractures of the neck of the talus. *J Bone Joint Surg* **52A**: 991–1002

Pennal GF (1963) Fractures of the talus. *Clin Orthop* **30**: 53–63

Sneppen O, Christensen SB, Krogsoe O et al. (1977) Fracture of the body of the talus. *Acta Orthop Scand* **48**: 317–324

Szyszkowitz R, Reschauer R, Seggl W (1985) Eighty-five talus fractures treated by ORIF with five to eight years of follow-up study of 69 patients. *Clin Orthop* **199**:97–107