Original article

Talar fractures: long-term results

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Abstract. *Background:* talar fractures are rare and potentially invalidating injuries. Traditional x-ray projections often do not provide comprehensive and exhaustive view of the talus; in order to determine the best therapeutic strategy and obtain early and precise prognostic data diagnostic examination usually includes oblique projections and computed tomography scans. In displaced fractures treatment is surgical, with percutaneous or open osteosynthesis. *Methods:* 16 patients affected by talar fractures were treated and assessed with the Ankle Hindfoot Scale, the Ankle Osteoarthritis Scale and radiographic investigation. *Results:* consolidation was obtained in all cases. None avascular bone necrosis was observed at the follow-up. Mean score divided into the two components was 69.3 on the first scale and 38.4% on the second scale. *Conclusions:* talar fractures are challenging injuries for orthopedic surgeon. The evolution of this type of fractures, above all in the most complex fractures of the body and of the neck, is often poor and characterized by severe complications. Early treatment is important for recovery. (www.actabiomedica.it)

Key words: Talus, astragalus, fracture, necrosis, neck, talar body

Introduction

Fractures of the talus represent 0.5% of bone fractures (1-3) and in a high percentage of patients (50%) are associated with malleolar, metatarsal and calcaneal fractures (4, 5); 13% of these lesions are open. As suggested by Coltar (6), talar fractures can be divided according to the anatomical part of the astragalus, as follows: fractures of the neck, of the head, of the body and of the processes. Neck fractures, further classified by Hawkins (7) and Canale and Kelly (8) into four types based on the degree of fragment displacement and associated dislocation, are the most common, exhibiting an incidence as high as 50% (7-9). They are caused by injuries in dorsal-flexion and supination of the foot, as described in 1919 by the English battlefield surgeon Anderson, who firstly observed them in Royal Air Force pilots experiencing air crashes and coined the term ”aviator's astragalus” (6). Fractures of the head are fairly rare, about 5-10%, and are the consequence of a direct dorsi-flexion forced movement of the foot (generally after high-energy street accidents or falls from a height of over 3 meters). Fractures of the talus body, classified by Sneppen (10) into 5 groups, are the third by frequency, ranging between 5 and 28% across different studies. These fractures can be isolated, or associated with displacement of the body or of the subtalar joint. Usually trauma is due to compression forces. Fractures of the body include osteochondral injuries of the talar dome (Sneppen Group 1) which were classified in 1959 into four stages by Berndt and Harty (11). Fractures of the lateral process of the astragalus (Sneppen Group 4) can be caused by an axial impact and dorsal flexion of the ankle but are most commonly due to a trauma in external rotation and eversion (12). In fractures of the posterior tubercle of the astragalus (Sneppen Group 3), also known as “Cloquet-Shepherd fracture (13)”, two injury mechanisms are supposed: the first is a forced torsion or flexion of the foot; the second is due to a violent impact of the apophysis on the heel following a fall on the foot plant (14). Finally, fractures of the medial process of the astragalus (Sneppen Group 3), the least common, are due to a combined movement in pronation and dorsal flexion of the foot which leads to the avulsion of a bone fragment by the deltoid ligament.

Imaging assessment is essential for the study and management of these fractures. Because of its complex three-dimensional morphology, it is virtually impossible to obtain a comprehensive and exhaustive view of the talus by traditional radiography; a 40-50% incidence of fracture misdiagnosis with conventional radiograms has been reported. Further orthogonal x-ray projection, radiographic investigation must also include oblique views (15-17). Computed Tomography (CT) is very useful in the case of comminuted fractures, to investigate the fracture morphology and any articular involvement, while Magnetic Resonance Imaging (MRI) can identify any osteochondral lesion and associated soft tissue injuries (18-21).

Ankle and subtalar mobility, as well as support of the foot's medial column depend on the anatomical integrity of the talus; in this bone there are seven articular surfaces, and 60% of its area is covered with cartilage. Arterial blood supply is ensured by distal vessels originating from the anterior and posterior tibial arteries; the main one is the tarsal canal artery, a branch of the posterior tibial artery, penetrating from beneath the astragalus neck (22, 23). Such anatomical and biomechanical complexity complicates the treatment of these fractures, implying a worse prognosis, as well as a greater risk of complications which can also be invalidating (early post-traumatic osteoarthritis, pseudoarthrosis, malunion and avascular bone necrosis).

The aim of the treatment of these fractures is to achieve recovery, allowing painless walking with stable and without stiffness of the foot. For undisplaced fractures the treatment is conservative, with immobilization in plaster and a 6-8 week delayed weight bearing. Displaced fractures must be surgically treated, anatomically reduced and synthesized. Early operation will safeguard soft tissues and its vascularization.

Closed reduction and percutaneous fixation is usually difficult to obtain and in most cases open reduction is necessary. The choice of the surgical approach is determined by the type of fractures, its severity and the condition of the surrounding soft tissues.

Materials and methods

From 1998 to 2004, 16 patients with a diagnosis of fracture of the talus were treated at the Unit of Orthopedics, Traumatology and Functional Rehabilitation of the Department of Surgical Sciences of the University of Parma. On admission, each patient underwent radiographic investigation (antero-posterior, latero-lateral, oblique x-ray projections). In 12 cases, CT with three-dimensional reconstruction was carried out to better characterize the fracture and to plan the appropriate type of treatment: 81.25% of cases (13 fractures) required surgery, and the remaining 18.75% (3 fractures) was treated through conservative treatment. For each patient, the following parameters were assessed: age at time of injury, type of fracture, traumatic mechanism, time to fracture consolidation and any complications occurred after treatment.

All patients were clinically assessed with the Ankle Hindfoot Scale (AHS) (24) and the Ankle Osteoarthritis Scale (AOS) (25). Initial radiographies and CT scans of the injury were analyzed, in order to divide the fractures according to the classification of Coltar (6). Fractures of the neck were further subdivided according to the classification of Hawkins modified by Canale and Kelly (7, 8) and fractures of the body according to the classification of Sneppen (10). Osteochondral lesions of the talar dome (Sneppen Group 1 fractures) were excluded from the study. Follow-up radiographies were analyzed to highlight any loss of reduction, to assess the progress of consolidation process and to identify any early complications. Final x-ray views were examined in order to identify the signs of late complications and to verify the final consolidation.

Results

Our report of 16 patients included 2 (12.5%) non-displaced fractures of the head, 11 (68.25%)

fractures of the neck, and 3 (18.75%) fractures of the body, in accordance with Coltar classification (6). According to Hawkins classification (8) modified by Canale and Kelly (7), 1 fracture of the neck (9.1%) was Type 1, 7 (63.6%) were Type 2 and 3 (27.3%) were Type 3. Out of the three fractures of the body, in accordance with the Sneppen classification (11), 1 was a Group 2 fracture Type 1C, 1 a Group 2 displaced fracture Type II and 1 a Group 5 fracture. No open fractures and no associated fractures were present. Eleven patients (68.75%) were male, and 5 (31.25%) female (mean age 29 years) (range: 16 - 58 years). Mean follow-up was 5.8 years (range 4 - 10 years). In 56.25% of cases (9 patients) the cause of fracture was a street accident, in 31.25% (5 patients) an accidental fall from over 3 meters, and in 12.5% (2 patients) an athletic injury.

The two fractures of the head and the fracture of the neck were conservatively treated through immobilization in plaster for 10 weeks, with optimal clinical and radiographic results.

The remaining 10 fractures of the neck and the 3 fractures of the body were surgically treated through screw fixation; in 3 cases (18.75%) percutaneous Kirschner wires were also used in combination with screws for one month (Figures 1 and 2). Antero-medial approach was used in 76.9% of cases (10 patients), anterolateral access in 15.4% (2 patients) and posterior-lateral access in 1 patient (7.7%). The choice of the surgical approach depended on the fracture site and soft tissue condition. Immobilization in plaster after surgery lasted about 60 days with partial and protected weight bearing allowed one month after surgery. Consolidation was obtained in all cases, in average 3.4 months after injury (range 2 - 5 months).

Figure 1. A) Type 2 neck fracture of the talus. B) Post-operative x-ray. C) X-ray after 1 month with initial new bone apposition. D) X-ray after 6 years (fracture consolidated)

Figure 2. Clinical assesment after 6 years: good result

Radiographic analysis showed no avascular necrosis of the talus, although in 25% of cases (4 fractures of the neck) moderate reduction of bone trophism was observed. Clinical assessment showed that 81.25% of subjects developed functional limitations, predominantly in dorsal flexion. Hindfoot mobility also exhibited limitations, with decreased articular excursion in inversion and eversion.

Mean score divided into the two components (AHS and AOS) was 69.3 on the AHS and 38.4% on the AOS. According to the AHS scale (Figure 3) half of the patients obtained a medium result: they reported moderate pain, difficulty in performing recreational activities and walking on uneven ground, with partial reduction of dorsal and plantar flexion, of inversion and eversion; they also perceived articular instability; 25% of cases obtained good results and 17% ex-

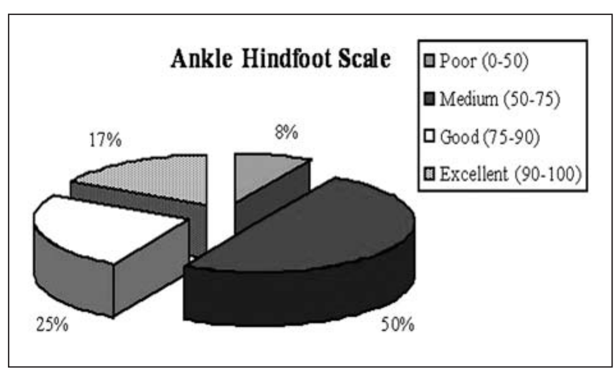

Figure 3. Results according to AHS scale

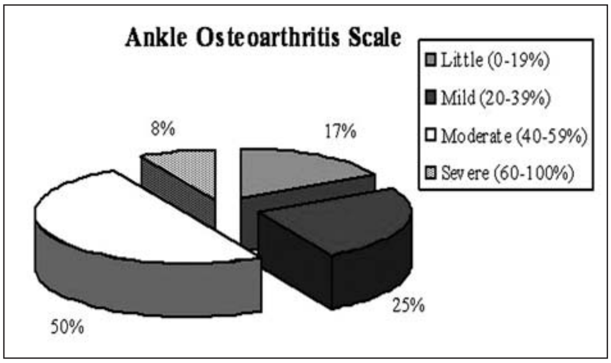

Figure 4. Results according to AOS scale

cellent results, with no major functional reduction, while outcomes were poor in 8% of patients, who reported persistent pain, functional restrictions in activities of daily living, and major articular reduction with perceived ankle instability. According to the AOS scale (Figure 4) half of the subjects exhibited a degree of residual disability between 30% and 60%, while mild or little disability was observed in 42% of patients. High level disability (over 60%) was observed in 8% of cases, with pain during most daily activities, including walking up and down the stairs, and the inability to run even short distances, due both to extreme ankle rigidity and to pain.

Discussion

Fractures of the astragalus are not frequent (less than 1% of all bone injuries).

The choice between conservative or surgical treatment depends on whether the fracture is displaced or undisplaced. Preoperative imaging is important for the selection of the most appropriate treatment; it should not be restricted to standard x-ray projection (antero-posterior, and latero-lateral), but should be supplemented by specific views for the neck of the astragalus and by CT scan and MRI.

These injuries are usually a consequence of high-energy traumas and are often associated to soft tissue damages. These influence the surgical approach. The incision must take vascularization into account, keeping in mind that it is limited and provided by end vessels originating from the anterior and posterior tibial arteries, since the astragalus has not muscular insertions.

Displaced fractures of the astragalus must be reduced and stabilized as soon as possible, especially Hawkins type 3 and 4. Closed reduction must not cause further tissue damage and, if anatomic reduction is obtained, osteosynthesis may also be percutaneously performed.

If an open reduction is necessary, the choice of surgical approach depends on the fracture type and site, its severity and the condition of the surrounding soft tissues. Anterolateral access minimizes vascular damages whereas antero-medial is useful in case of posterior displacement of the neck of the astragalus, and when a fracture of the medial malleolus is associated. Posterior access may be employed in the case of fixation from posterior to anterior. In order to improve viewing during surgery, the fracture site may be exposed through osteotomy of the malleoli; if the medial malleolus is involved, particular care should be ensured to avoid further vascularization damage, preserving the deltoid ligament which contains an important arterial vessel for the body of the talus.

Fractures of the head are fairly rare, constituting 5-10% of all fractures of the astragalus and can be worsened by early arthrosis of the astragalus-scaphoid joint. In our experience, such fractures occurred only in two cases (12.5%) and being non-displaced, their treatment was noninvasive, with good clinical and radiographic results. Fractures of the neck are the most common (up to 50% of cases) and those at greatest risk of complications by vascular damage (aseptic avascular necrosis), including those exhibiting little displacement (Hawkins Type 1) (26-33). The frequency of avascular necrosis is related to the degree of displacement at the time of injury, because fracture segments tear the vascular structures supplying the astragalus. Type 1 non-displaced fractures are associated with osteonecrosis in 0 to 13% of cases; for Type 2 fractures, this percentage varies between 20 and 50% and for Type 3 and 4 it is nearly 90% (29). None of the 11 fractures of this group in our cases (68.25%) exhibited avascular necrosis of the astragalus, while in 4 cases (25%), 1 Hawkins Type 3 and 3 Type 2 fractures, radiographic follow-up revealed moderate reduction of bone trophism with poor scores at clinical assessment. For Type 3 fracture, AHS score was less than 50 points (extremely poor outcome) and AOS score greater than 60% (poor outcome). For the three Type 2 fractures, AHS score ranged between 50 and 75 points (medium outcome) and between 40 and 59% for AOS (moderate outcome).

The most widely used fixation method for fractures of the neck of the astragalus is osteosynthesis with one or more screws directed from posterior to anterior. This positioning enables optimal fixation stability, often judged superior to antero-posterior fixation systems. Posterior-lateral access is the one used in this situation. Our findings are in contrast with the abovementioned considerations; in all fractures of the neck of the astragalus we treated, antero-posterior screw osteosynthesis was performed and fixation instability was never encountered.

The frequency of fractures of the body of the astragalus reported in the literature ranges from 5% to 28%. The three patients with a fracture of the body obtained medium results on the AHS (between 50 and 75 points) and moderate results on the AOS (between 40 and 59%).

Fractures of the body are those that most often lead to degenerative complications with the onset of early osteoarthritis (this complication is reported with varying degrees of severity in over half of patients). Osteoarthritis alterations are a consequence of the articular and vascular damage occurred at the time of injury, and secondary to the anomalous weight distribution taking place at the ankle and/or subtalar joint. This complication is described in every talar fracture. In many instances, it is firstly radiographically detected, and then clinically. Clinical findings did not always correspond to radiographic signs of initial secondary osteoarthritis, which were present, at different degrees, in 13 out of the 16 subjects in our casemix, whereas only 8 patients exhibited, to different degrees of severity, active and passive articular deficits, in plantar and dorsal flexion, in inversion and eversion.

At follow-up evaluation, none of the patients required arthrodesis or replacement. In three cases, positioned screws were removed, improving pain and articular motion.

Conclusions

Talus fractures are uncommon. These severe injuries can lead to serious complications and invalidating disability, especially without adequate and timely treatment. The clinical and instrumental approach should be precise, and supplemented by second level instrumental investigations, such as a CT scan and MRI, which allow for a detailed fracture analysis and the determination of the best treatment. Noninvasive treatment is now reserved to stable and undisplaced fractures. When the fracture is unstable and cannot be reduced, open surgical reduction and osteosynthesis is the best solution. The incidence of early and late complications remains high, and the worst outcomes are observed in the most complex fractures of the neck (Hawkins Type 3) and of the body (Sneppen Group 5).

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