Journal of Clinical Orthopaedics and Trauma 23 (2021) 101648

Contents lists available at ScienceDirect

Journal of Clinical Orthopaedics and Trauma

journal homepage: www.elsevier.com/locate/jcot

Original article

Retrospective analysis of treatment strategies and clinical outcome of isolated talar dislocations

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ARTICLE INFO

Article history:
Received 29 April 2021
Received in revised form
26 July 2021
Accepted 12 October 2021
Available online 18 October 2021

Keywords:
Talar dislocation
Peritalar dislocation
Foot trauma
Ankle trauma

ABSTRACT

Talar dislocations are rare injuries of the foot and ankle and require quick and decisive diagnostic and therapeutic decisions. Evidence concerning the treatment and outcome of these injuries is sparse. The aim of this study was to analyze all talar dislocations of the last ten years treated in a large German level I trauma center in an effort to add to the experience on these injuries. Methods: All patients with a talar dislocation injury were retrospectively included. Medical reports, x-ray and computertomography scans were analyzed for the sex, age, trauma mechanism, and injury classifications as well as for the clinical outcome as measured by the Foot Function Index (FFI). Results: A total of 18 patients were included in this study: Luxatio pedis cum talo (n = 1), Luxatio tali totalis (n = 3), Luxatio pedis sub talo (n = 14). Analysis of the therapeutic algorithms revealed that only one patient was treated conservatively, the other 17 patients underwent operation. In most cases, stabilization was achieved using an external fixator and if necessary, the subtalar and talonavicular joints were temporarily stabilized using K-wires. The mean follow-up time was 4.25 years (2.05 SD) and the mean FFI-sum score 45.00 (42.26 SD). Two patients required subtalar fusion two years after the injury. Conclusion: Isolated talar dislocations can have a good outcome and be effectively treated in the emergency setting by basic techniqes if neurovasular structures are not injured. Often, these injuries are associated with fractures of adjacent bones which then need complex reconstruction.

1. Introduction

Talar dislocations are rare injuries of the foot and ankle and account for merely 2% of dislocations of all large joints[1]. These injuries occur mainly after high-energy trauma to the plantarflexed foot. Depending on the force of the energy, the talus may dislocate medially, laterally, anteriorly or posteriorly.

The talus is referred to by Kapandji as the “unusual bone” because it is entirely covered by articular surfaces, it is encaged by tendons but has no muscular attachments, forms three joints and resorbs the energy of the entire body weight and distributes it over the entire foot[2]. The superior articular surface, the trochlea, forms the talocrural joint along with the distal end of the tibia. The talocrural joint only allows for dorsi- and plantarflexion and makes – for instance – jumping possible. As soon as walking or running occurs on tilted ground, the forces of the body weight have to be gimballed. This cardan function is made possible by inversion and eversion movements of the subtalar joint, which is formed by the inferior articular surface of the talus and the calcaneus. The third joint of the talus is the talonavicular joint which makes supination and pronation movements possible. The talus is therefore often referred to as a “heterokinetic cardan joint”[3,4].

In all of the three joints, dislocations may occur and are accordingly classified as follows: In a “Luxatio tali totalis”, the talus flips out of the talocrural, the talonavicular and the subtalar joint completely (tri-articular dislocation). In a “Luxatio pedis cum talo”, the talus dislocates out of the talocrural joint with the subtalar and talonavicular joint being not affected (mono-articular dislocation). In a “Luxatio pedis sub talo”, the talus dislocates out of the subtalar

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https://doi.org/10.1016/j.jcot.2021.101648
0976-5662/

and talonavicular joint (bi-articular dislocation) (Fig. 1).[4]

Evidence concerning the treatment and outcome of these injuries is rare. In the literature, merely three case series and ten case reports are available with group sizes ranging from n = 5 to n = 8 reporting on Luxatio tali totalis[4–8]. Luxatio pedis cum talo are even rarer with only one case series of n = 3 and one case report available in the literature[4,9]. Luxatio pedis sub talo, on the other hand, have been more frequently reported about with seven case series available in the literature and the largest series having analyzed n = 27 patients[1,4,10–15].

The aim of this study was to analyze all talar dislocations treated in a large German level I trauma center over the last ten years in order to add to the sparse experience on these injuries and to give a detailed overview of how specifically these injuries were treated and what the outcome was.

2. Methods

Medical records of all patients who were admitted to a large German level I trauma center and who were diagnosed a talar dislocation injury were included in this study. The search was conducted using a patient management software (SAP Business Client 6.5, SAP Walldorf, Germany) and aimed to include all ICD-10-GM codes of dislocations of the foot and ankle joint within the last ten years. This study was approved by the local ethics committee (EA2/025/21).

The medical documentation of these patients were scanned for specific charateristics such as age, sex, trauma mechanism, details of the operative or non-operative therapy (reduction technique, fixation technique) and associated injuries of the foot and ankle such as fractures or vascular injuries. All talar dislocations were then classified into either “Luxatio pedis cum talo”, “Luxatio pedis sub talo” or “Luxatio tali totalis”. For statistical analyses, trauma mechanisms were categorized into “high-energy” and “low-energy” trauma. High-energy trauma were: Fall from height >3 m, bike accidents if caused by crashing against an automobile, motor bike accidents, car accidents with a delta V ≥ 30 km/h. Low-energy trauma were: Sports injuries (e.g. soccer, volleyball), falling from stairs, bike accidents without the involvement of a motorized vehicle.

In the clinic which undertook this study, the clinical outcome is usually assessed using the Foot Function Index (FFI). The FFI is a self-administered two-part score including a pain (FFI Pain) and function (FFI Function) scale with higher points correlating to worse outcomes (maximum score is 100 points for each of the scales). The FFI is reported for each scale separately and as the sum of both scales (FFI Sum)[16]. If patients re-visited the clinic for a follow-up visit, the results of this score were additionally analyzed if documented.

Statistical analysis was performed using “R” and the software

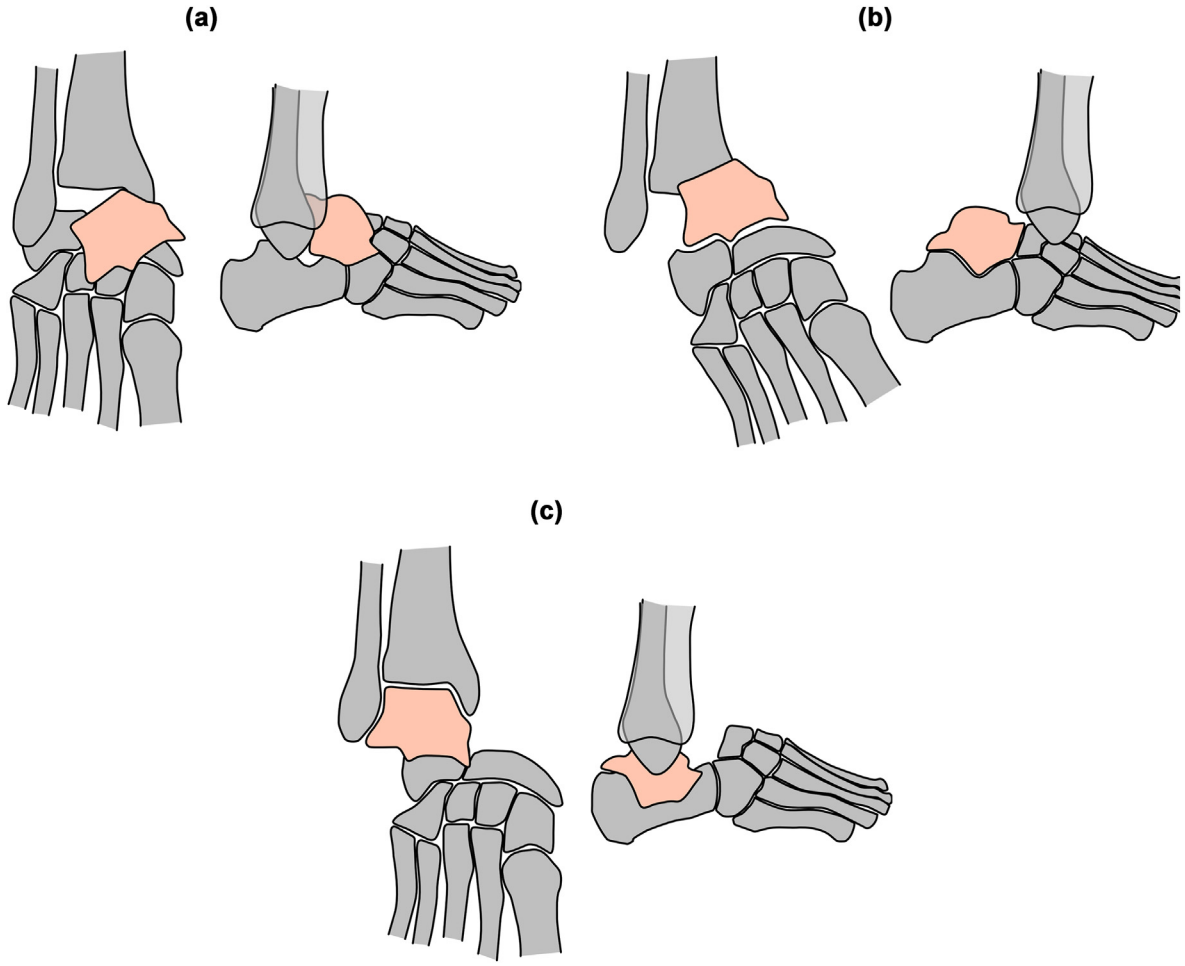

Fig. 1. Classification of talar dislocations. A) “Luxatio tali totalis”: The talus flips out of the talocrural, the talonavicular and the subtalar joint completely (tri-articular dislocation). B) “Luxatio pedis cum talo”: The talus dislocates out of the talocrural joint with the subtalar and talonavicular joint being not affected (mono-articular dislocation). C) “Luxatio pedis sub talo”: The talus dislocates out of the subtalar and talonavicular joint (bi-articular dislocation).

RStudio© (RStudio, Inc., Boston, USA). Results are given as means with standard deviation (SD) if not stated otherwise. Differences between groups were calculated using the Wilcoxon test for non-parametric data, Bonferroni correction was applied for multiple testing.

3. Results

The search revealed 649 patients which were then all manually analyzed using medical reports, X-ray and computertomography (CT) images. This resulted in 18 patients with talar dislocations who were finally included in this study. The majority of patients had sustained a Luxatio pedis sub talo (77.8%), one patient demonstrated a Luxatio pedis cum talo and three patients a Luxatio tali totalis. The most frequently observed trauma mechanism was a fall from a height >3 m. Three of those seven patients fell through a breaking roof while doing maintenance work, one patient was an acrobat who fell off his trapeze, another patient fell off a cliff while free-climbing and two patients were jumpers trying to commit suicide.

Of all 18 patients, only one was treated conservatively (Luxatio pedis sub talo after bike accident) since CT scans demonstrated anatomical alignment of the subtalar and talonavicular joints without adjacent fractures of the foot and ankle, all other patients underwent surgery (Fig. 2). Seven patients (38,9%) had open dislocations, two of these seven patients had to undergo plastic reconstruction using a mesh graft (both Luxatio pedis sub talo) (Table 1). Three patients (16.7%) sustained a rupture of the posterior tibial artery (all three cases Luxatio pedis sub talo). In two cases, the artery could be primarily reconstructed, in one case reconstruction was not possible and the artery had to be ligated.

Analysis of the therapy algorithm revealed that initial reduction of the dislocated talus could be achieved in a closed manner in 16 patients (88,9%). The two cases in which open reduction was required was one patient with a Luxatio pedis sub talo and one patient with a Luxatio tali totalis. Eleven patients (64.7%) were required to undergo immediate emergency operation, in the remaining seven cases (35.3%), following closed reduction, initial stabilization of the ankle joint could be achieved through cast immobilization.

In these emergency operations (n = 11), stabilization was achieved with an external fixator in seven cases (Table 2). Six of those patients were required a second operation in the following days in which the subtalar and talonavicular joints were temporarily

Table 1
Baseline characteristics of all n = 18 analyzed talar dislocation injuries. Numbers are given as total count and percentages in round brackets.

Patients (n)	18
Diagnosis (%)	
Luxatio pedis cum talo	1 (5.6)
Luxatio pedis sub talo	14 (77.8)
Luxatio tali totalis	3 (16.7)
Age (median [IQR])	30.00 [23.75, 43.25]
Sex = m	13 (72.2)
Trauma mechanism (%)	
Bike accident	2 (11.1)
Car accident	1 (5.6)
Fall from height >3 m	7 (38.9)
Fall from stairs	2 (11.1)
Motor Bike Accident	1 (5.6)
Sports Injury	5 (27.8)
Days on ward (median [IQR])	11.00 [8.25, 13.75]
Open dislocations (Gustilo Anderson classification) (%)	7 (38.9)
I°	1 (5.6)
II°	1 (5.6)
III°	5 (27.8)
Closure of open wounds	
Primary suture	2 (28.6)
Secondary suture	2 (28.6)
Mesh graft	3 (42.9)

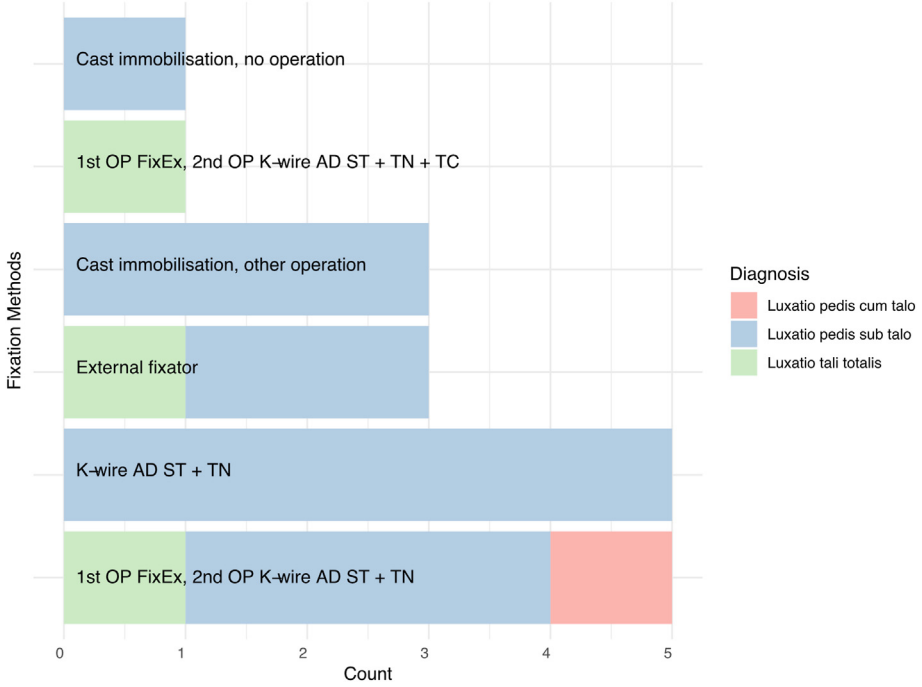

Fig. 2. Bar graph displaying the different therapies and operations (OP) used for talar dislocation injuries. In most cases, following open or closed reduction, the ankle joint was fixated in a damage-control operation using an external fixator (FixEx). Temporal arthrodesis (AD) of the subtalar (ST) and talonavicular (TN) joint was then performed in a second operation. In three cases, an operation was performed for fixation of collateral fractures ("other operation") but without fixation of the ST or TN joint. In one case, following an external fixator, the talocrural (TC) joint was fixated in addition to the ST and TN joint.

Table 2
Overview of the conducted measures when patients had to undergo emergency operation. AD = Arthrodesis, ST = subtalar joint, TN = talonavicular joint.

Emergency operations (%)	11
External fixator	6 (54,5)
External fixator, K-wire AD ST + TN	1 (9.1)
K-wire AD ST + TN	3 (27.3)
Wound debridement only	1 (9.1)

stabilized using K-wires. In the remaining four patients which underwent emergency operation, the subtalar and talonavicular joint were primarily fixated using K-wires in three cases and in one case, merely debridement and irrigation procedures were performed because of a 3rd degree open Luxatio pedis sub talo.

Of the seven patients who did not undergo emergency operation, six were operated within the following days, one patient was treated conservatively (Table 1). In two patients, the talonavicular and subtalar joints were temporarily fixated using K-wires. The remaining four patients did undergo operation for open reduction of adjacent fractures, but since the talonavicular and subtalar joints were stable during dynamic testing using an image intensifier during the operation, fixation of these joints was refrained from (Fig. 3).

In summary, of all 18 patients, seven patients (38.9%) (six Luxatio pedis sub talo, one Luxatio tali totalis) did not require internal fixation of the dislocated joints. Of these seven patients, the joint was immobilized using a cast in four cases and in the other three patients, fixation was performed with an external fixator. In the remaining ten patients (61.1%), the dislocated joints had to be internally fixated using k-wires. All patients who underwent K-wire arthrodesis underwent removal of these implants six weeks after the primary arthrodesis operation.

Temporary K-wire arthrodesis of the calcaneocuboidal (CC) joint was conducted in six cases (33.3%). In all of these cases, in addition to the talar dislocation, a chopart joint dislocation with an unstable CC joint was present. In three of these seven patients, the cuboid was additionally fractured itself. Operative therapy of this fracture was performed using a x-plate in two of the cases, in one patient the CC K-wire arthrodesis was deemed sufficient for fracture fixation and in one case the cuboid fracture was addressed by open reduction and internal fixation by one cortex screw and an additional bridging plate overspanning the cuboid from the fifth metatarsal bone to the calcaneus (Fig. 4).

Other adjacent fractures included osteochondral flake fractures of the talus (n = 2) (1x Luxatio pedis sub talo, 1x Luxatio tali totalis), navicular fractures (n = 2) (1x Luxatio pedis sub talo, 1x Luxatio pedis cum talo), distal fibula fractures (n = 3) (2x Luxatio pedis sub talo, 1x Luxatio tali totalis), fractures of the sustentaculum tali (n = 2) (2x Luxatio pedis sub talo), fractures of the talus (n = 6) (6x Luxatio pedis sub talo) and fractures of the calcaneus (n = 3) (3x Luxatio pedis sub talo), all of which were operatively treated by open reduction and internal fixation.

Of the entire study cohort, 14 patients (77.7%) re-visited the clinic for a follow-up examination. The clinical outcome had been assessed using the FFI in twelve of these 14 patients (Table 3). The mean overall FFI-sum score was 45.00 (42.26 SD). In two of these patients who had sustained a Luxatio pedis sub talo, the subtalar joint had to be fused two years after the operation due to osteoarthritis. The highest FFI-sum score of 124.44 was recorded for a 45 year-old female patient who tried to commit suicide by jumping from the third story of a building and sustained an unstable lumbar vertebra fracture as well as a Luxatio pedis cum talo of the left ankle. The left foot had additional injuries and fractures of the Chopart and Lisfranc joint line. In addition to temporary K-wire arthrodesis of the talocrural joint, the Chopart and Lisfranc joint lines were stabilized using a bridging plate from the first metatarsal to the talus and additional K-wires.

Statistical analysis revealed that over the entire study cohort, there was no significant difference between high and low energy trauma concerning the FFI-pain, FFI-functional and FFI-sum score.

4. Discussion

This study could report treatment strategies for talar dislocation injuries over an extended time span from 2010 to 2020. The most important findings were that in the majority of the cases, the initial damage-control treatment followed basic and straightforward techniques; moreover, the overall outcome was relatively good.

The majority of patients could be treated by closed reduction and cast immobilization or by operative stabilization with an

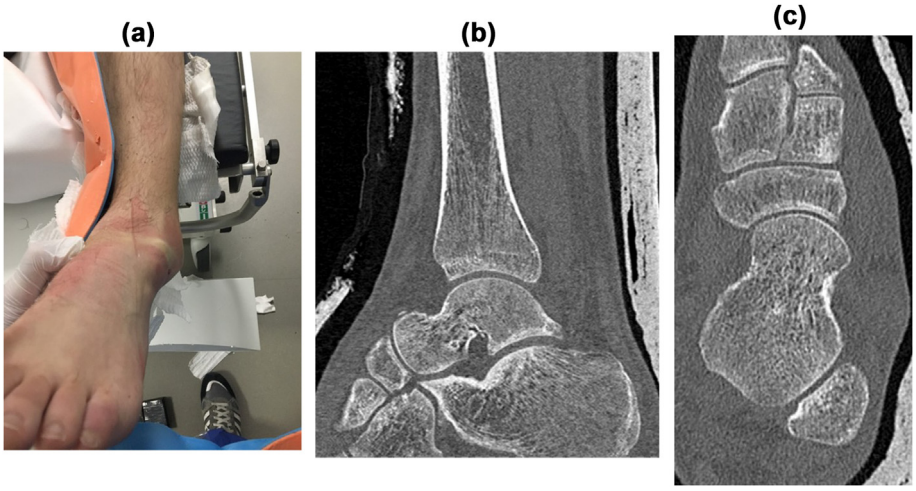

Fig. 3. a–b) Case of a 30 year-old male patient who sustained a closed medial subtalar (Luxatio pedis sub talo) dislocation due to a bike accident. Reduction was done under sedation in the emergency department in a closed manner. Stabilization was achieved using cast immobilization. One day after the injury, dynamic stress testing of the joints was conducted under general anesthesia in the operating room using an image intensifier and because the joints were stable, K-wire arthrodesis was refrained from. b-c) Similrarly, in the computertomography scans, both the talonavicular as well as the subtalar joints did not demonstrate any form of (sub-) luxation. Moreover, no adjacent fractures could be seen. In the follow-up visit four years after the injury, the patient did not have any complaints in the foot and ankle joint (FFI-sum score 0).

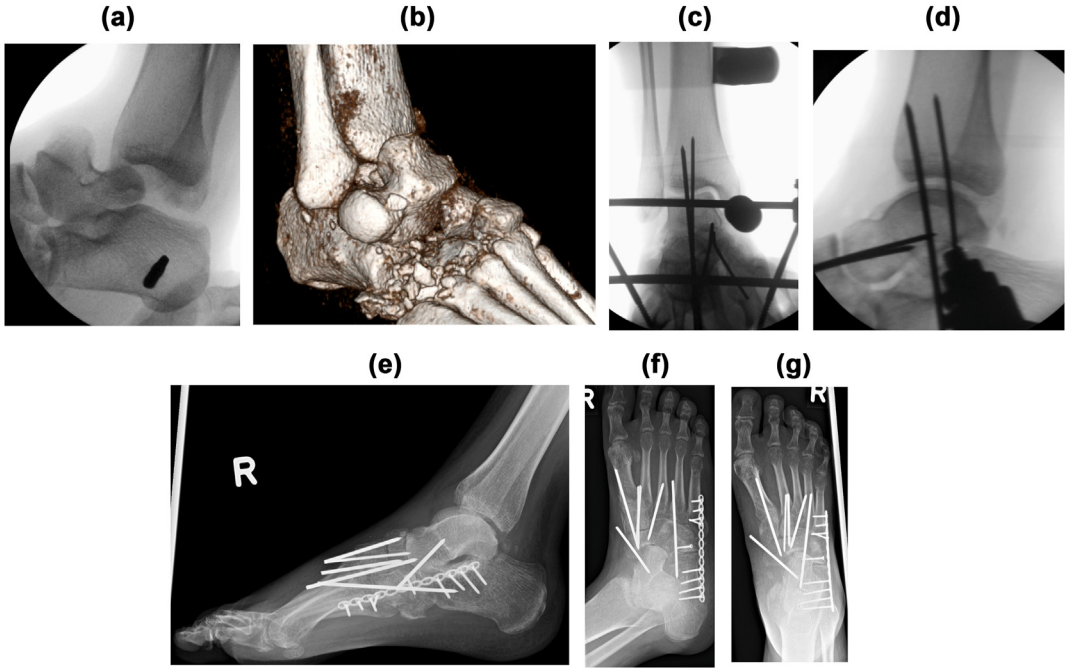

Fig. 4. Case of a 18 year-old female patient who tried to commit suicide by jumping from the fifth story of a building. Amongst multiple injuries of the skeleton and intraabdominal organs, she sustained a closed Luxatio tali totalis on the right side, which had to be reduced in an open manner using an anterior approach to the ankle. a-d) Stabilization was achieved using an external fixator and by additionally fixating the talocrural, subtalar and talonavicular joint using K-wires. e-f) 23 days after the injury, the injury was treated by open reduction and internal fixation of the cuboid fracture using a 2.0 mm corticalis screw and an additional bridging plate as well as temporary K-wire arthrodesis of the calcaneocuboid joint to stabilize the Chopart joint. The Lisfranc injury was fixated by open reduction and open as well as percutaneous K-wire arthrodesis.

Table 3
Results of the clinical outcome assessed by the Foot Function Index (FFI), which is reported separately with a pain (FFI-pain) and a function (FFI-function) score as well as the sum of both.[15] Results are give as mean with standard deviation (SD). Each scale can score a maximum of 100 points with higher points correlating to worse outcomes. In total, the outcome of eleven out of 18 patients was assessed using the FFI.

	Patients assessed	FFI-Pain (SD)	FFI-Function (SD)	FFI-Sum (SD)
Luxatio pedis sub talo	n = 9	12.96 (16.26)	29.16 (24.99)	42.13 (38.34)
Luxatio pedis cum talo	n = 1	44.44	80.00	124.44
Luxatio tali totalis	n = 2	7.64 (0.98)	10.56 (7.07)	18.19 (8.05)
Total	n = 12	12.64 (13.43)	28.89 (24.49)	41.53 (35.20)

external fixator and/or, if necessary, by temporary and percutaneous K-wire arthrodesis of the subtalar and talonavicular joint. However, 13 patients in this study (72.2%) had additional fractures of adjacent bones such as the navicular or cuboid bone, the calcaneus or more complex injuries of the Chopart and Lisfranc joint lines. After damage-control surgery, these injuries had to be addressed by experienced foot and ankle surgeons.

Similarly, a study published in 2011 could report that patients with isolated subtalar dislocations without any adjacent talar fractures who were conservatively treated by cast immobilization could already begin partial weight-bearing three weeks after the injury and began full weight-bearing as early as by the fifth week [11]. In this study, stabilization of subtalar dislocations could be achieved by cast immobilization in four of 14 cases. Three of these patients underwent operative stabilization of adjacent fractures, but the dislocated talus itself did not require operative intervention.

Accidents resulting in a Luxatio tali totalis or Luxatio pedis cum talo can, on the other hand, be more complex and all of these cases in this study required operative stabilization. For these injuries, worse outcomes compared to isolated subtalar dislocations have been reported [4]. One reason for this observation could be that these injuries may more frequently be the result from high-energy trauma and therefore additional injuries of the foot and ankle joints are more often [6]. In this study, of the three patients with a Luxatio tali totalis, one patient jumped from the fifth story trying to commit suicide, one patient sustained a high-energy motorcycle accident and one patient sustained a high-energy supination trauma during a soccer match.

The canalis tarsi artery, which originates from the posterior tibial artery, is the most important artery for the talus and an injury to this blood supply can lead to avascular necrosis and therefore to posttraumatic osteoarthritis of the subtalar joint[4,6,17]. In this study, a case was presented in which an open subtalar dislocation – without talar fractures – lead to a rupture of the posterior tibial artery and consequently to osteoarthritis of the subtalar joint, which had to be fused (Fig. 5).

In the literature, the overall outcome of talar dislocations has been reported to be relatively good, although both the reported outcome measures as well as the outcome ranges are quite wide. Several studies assessed the outcome using the American Orthopaedic Foot and Ankle Society (AOFAS) score ranging from 45 points to 100 points and subtalar dislocations were associated with higher (better) scores than Luxatio tali totalis[6,10,15,18]. In contrast, this study reported better outcomes for Luxatio tali totalis compared to Luxatio pedis sub talo – these results might however be biased due to the small number of patients. The outcome after

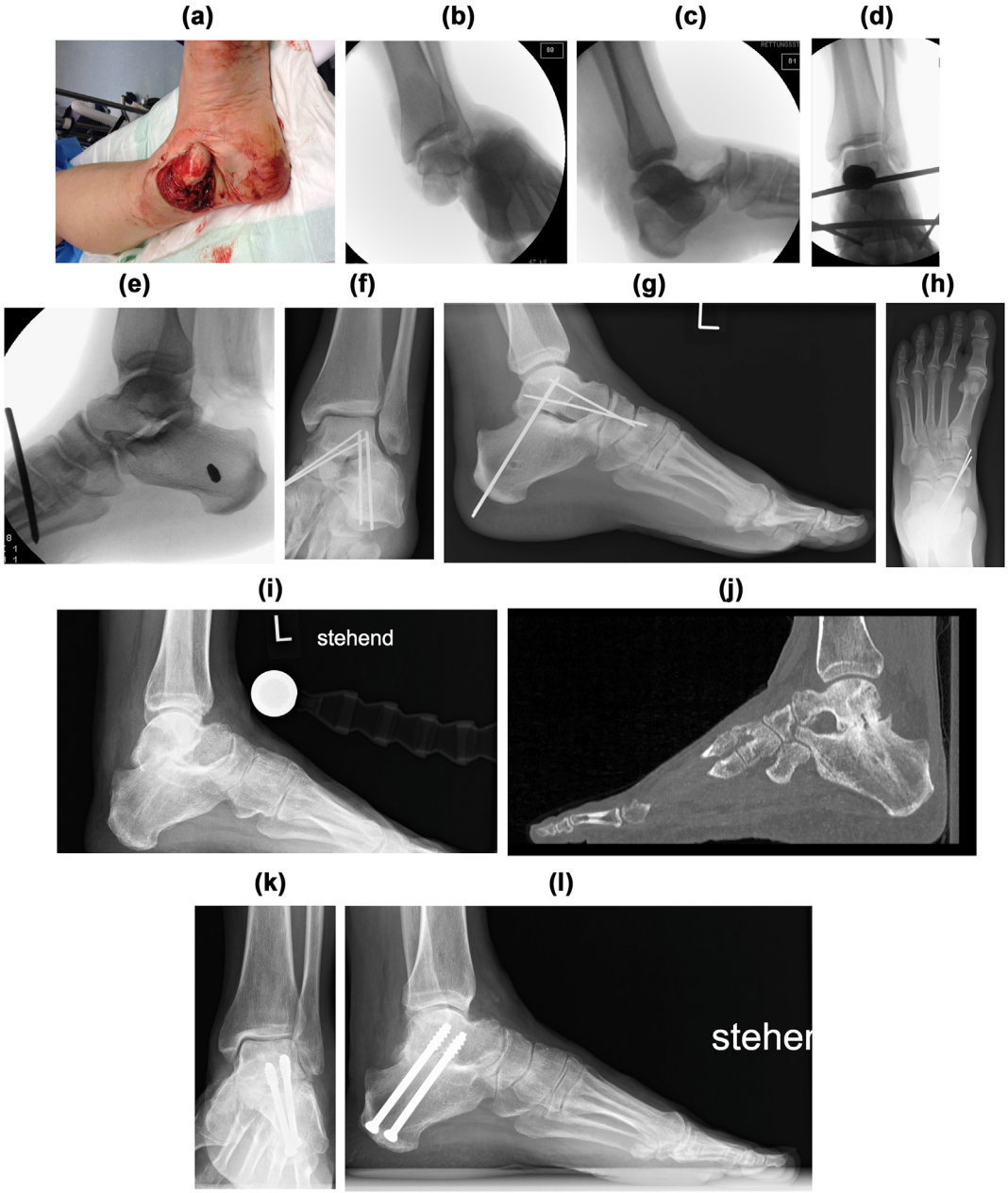

Fig. 5. a-c) Clinical case of a 38 year-old female patient who sustained a third degree open subtalar dislocation with a rupture of the posterior tibial artery while playing volleyball. d-e) The injury was reduced and fixated using an external fixator in the operation room under general anesthesia. In addition to primary reconstruction of the posterior tibial artery, debridement and irrigation of the subtalar joint was additionally performed. The open wound was covered with a synthetic skin replacement (Epigard, Biovisin, Ilmenau, Germany) and second-look operation with secondary wound-closure was performed two days later. f-h) Five days after the injury, temporary K-wire arthrodesis of the subtalar and talo-navicular joint was undertaken. K-wire removal was conducted after six weeks. i-l) Two years after the injury, the patient was diagnosed a posttraumatic osteoarthritis of the subtalar joint which was finally fused.

such an injury also depends on the time point of the follow-up examination and follow-up times, too, had a broad time span from ten months to more than six years[4,6].

This study could demonstrate that the overall outcome, assessed using the FFI, was relatively good and merely two patients required subtalar fusion due to osteoarthritis. Comparability to other studies is limited since results from the AOFAS score were not available in the medical reports. In the clinic which conducted this study, the FFI is more frequently used when assessing the postoperative outcome since it is a self-reported questionnaire and because the German translation of this scores has already been evaluated[16].

This study has several limitations. First of all, because of the retrospective nature, only medical reports and documentation which were already available could be analyzed. Therefore, specific outcome measures which were not documented, such as the range of motion, or the direction of the dislocated talus, could not be analyzed. Another limitation is the small number of patients which were included, particularly patients with a Luxatio tali totalis or Luxatio pedis cum talo, since these injuries are scarce. Because of these small group sizes, comparability between the three modes of talus dislocations is difficult and often, merely descriptive statistics can be used. One way to tackle this problem could be a prospective multi-center study, but since these injuries are extremely seldom, feasibility is at least questionable. A better way would be a multi-

center cross-sectional study in which patients who were already treated could be included to analyze retrospective data of the injury and treatment but further data such as current patient-related outcome measures could be added.

5. Conclusion

Talar dislocation injuries can effectively be treated by basic measures in the emergency setting rendering good clinical outcomes. Trauma surgeons have to be aware of collateral injuries such as ruptured neurovascular structures. After initial stabilization either using an immobilization cast or by operative measures, CT scanning is required to analyze the extent of the entire injury and to plan the further therapy of the dislocated talus as well as adjacent fractures.

Funding

None.

Declaration of competing interest

All authors declare that they have no conflict of interest.

Acknowledgements

None.

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