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Long-term follow-up after surgical treatment of talar fractures

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Abstract
Displaced talus fractures are rare and serious injuries with important outcomes. These fractures compromise motion of the foot and ankle and result in severe disability. Therefore, a satisfactory clinical outcome remains a challenge in the treatment of talus fractures. Displaced talar fractures have a high rate of long-term complications. The aim of our study was to evaluate the long-term outcomes of these fractures after operative treatment. This prospective study was conducted to assess the long-term outcome of all operated talus fractures who presented to emergency department of orthopedics, Govt. Bone and Joints Hospital, Barzulla an associated Hospital of Govt. Medical College, Srinagar from June 2019 to January 2022. Reduction was anatomical in 5 (25%) cases, nearly anatomical reduction in 10 (50%) and poor in 5 (25%). Early complications included 2 (10 %) superficial wound infections, 1 (5 %) deep infection and delayed union in 3 (15 %) patients. 4 (20%) patients presented an osteonecrosis of the talus. 5 (25 %) had undergone secondary surgery. 12 (60%) patients presented post-traumatic osteoarthritis in at least one ankle joint. 8 (47.05 %) patients had a normal hindfoot alignment, in 6 (35.29%) patients there was a varus malunion (from 8° of varus to 3° of valgus) and in 3 (17.65 %) cases there was a valgus malunion (10° and 12° of valgus). The average functional score was 69 points (range 43–92 points). Clinical outcome based on ankle-hind foot scoring was rated as excellent in 1 (5 %), good in 10 (50 %), fair in 5 (25 %), and poor in 4 (20 %). The complication rate for talar fractures was high, mostly osteonecrosis and osteoarthritis. The outcome could be improved by better evaluating these fractures with a CT scan, developing dual surgical approaches to best preserve the bone vascular supply and achieve better reduction, and improving the internal fixation hardware, especially the use of plates for comminuted fractures.

Keywords: Talus, trauma, fracture, management, surgery, long term follow-up, results, complications

Introduction
Fractures of the talus are quite rare and account for about 3% of all foot fractures [1-3]. However, the fractures' incidence ranks second in all tarsal bone fractures following the calcaneal fractures [4].

The fractures are severe and occur after high energy trauma with frequent associated injuries. Talus fractures compromises motion of the foot and ankle. Talar neck or body fractures arise from an excessive dorsiflexion of the foot with an axial compression [5-7].

It's a challenge to deal with talar fractures because of the bone's special anatomic characteristics. The talus has no muscle or tendon attachment and about 60% of the bone surface is covered with articular cartilage, which leaves a limited region for vascularization [8, 9]. The outcome of talar fractures varies widely and depends on the degree of initial damage and the accuracy of fracture reduction [10].

Fractures of the talar body are highly uncommon (13–23% of talus fractures) and present a greater risk for avascular necrosis than talar neck fractures [6]. Sometimes, non-displaced talar body fractures can be difficult to visualize adequately because of the shape of the tibiotalar articulation and the overhang of the anterior and posterior tibial plafond. Boyd and Knight have classified talar body fractures according to the plane of the fracture line. A type I fracture is a coronal or sagittal shear fracture, compared to a type II fracture which occurs in the horizontal plane [7]. The most common mechanism of injury resulting in a shearing-type talar body fracture is a fall from a height resulting in axial loading.

Fractures of the talus are rare and difficult to treat, it is difficult for the treating surgeon to acquire adequate experience in treating them and to conduct long term follow-up studies. Many authors recommend conservative treatment for displaced talar fractures, but displaced fractures require stable fixation and early physiotherapy [4, 11, 12].

The treatment of type I and type II talar neck fractures is not uniform in the orthopedic community. The option of closed reduction versus ORIF is dependent upon the degree of injury, surgeon experience, and preference. Avascular necrosis, malunion and osteoarthritis are the most frequent complications of talus fractures with variable incidences in the literature.

The purpose of this retrospective study was to evaluate clinical and radiological outcomes with a long follow-up of displaced and operatively treated talar fractures.

Materials and Methods

This prospective study was conducted to assess the long-term outcome of all operated talus fractures who presented to emergency department of orthopedics, Govt. Bone and Joints Hospital, Barzulla an associated Hospital of Govt. Medical College, Srinagar from June 2019 to January 2022. They were followed regularly for two years and recalled again after 3 years of trauma for assessment of functional outcome. A total of 20 patients were enrolled in this study, who met the inclusion criteria. The study excluded un-displaced talar fractures and all those fractures managed conservatively due to one or the other reason. Among the enrolled patients, there were 13 (65 %) men and 7 (35 %) women. The average age of the study population was 39.7 (range 21- 63) years.

All cases were evaluated preoperatively with weight-bearing radiographs of anteroposterior view, lateral view, and mortise view. Computed tomography scans and three-dimensional reconstructions were performed in all the patients to enhance our understanding of the fracture position and classification. Talar neck fractures were classified according to the Hawkins classification [5] modified by Canale and Kelly [13]. For talar body fractures, we distinguished coronal and sagittal fractures on CT scan. 4 (20%) fractures were open (20%) and classified according to Gustilo and Anderson Classification [14]. 6 (30 %) patients presented an associated injury. The demography of patients, fracture pattern and morphology are illustrated in table 1.

Table 1: The demography of patients, fracture pattern and morphology

Parameters		No. of patients	Percentage
Sex	Male	13	65
	Female	7	35
Age group	20-35	6	30
	36-50	9	45
	>50	5	25
Mechanism of injury	Road traffic accidents	12	60
	Fall from height	5	25
	Others	3	15
Fracture site	Neck	9	45
	Body	4	20
	Head	3	15
	Lateral process	3	15
	Posterior process	1	5
Fracture type	Open	4	20
	Closed	16	80
Associated injuries		6	30
Gustilo and Anderson fracture classification	Type I	1	5
	Type II	2	10
	Type III	1	5

Surgical Procedure

All patients were operated under spinal anesthesia on a radiolucent table and a tourniquet control. The goal of operative treatment was to obtain a near anatomic reduction of the fracture. Any of the standard anterolateral, posterolateral, posteromedial or anteromedial approach was used. The surgical approach depended upon the fracture pattern and hence a single or combined approach was used. Medial malleolus osteotomy was also performed if a better exposure was needed. Cancellous screws (4 mm) and small Herbert screws were used according to the fracture pattern.

Follow-up

Patients were kept non-weight-bearing by wearing an off-the shelf fracture boot with early foot and ankle motion for 10–12 weeks, until radiographs and clinical examination revealed evidence of union. Anteroposterior, lateral and mortise radiographs were routinely made at 2 weeks, 6 weeks, 10– 12 weeks and 6 months post-operatively. Additional radiography computed tomography scans and magnetic resonance imaging was performed as often as needed. Post-traumatic arthritis was defined as a decreased joint space, juxta-articular osteophytes, subchondral sclerosis and/or subchondral cysts seen either on plain radiographs or on computed tomography scans. Osteonecrosis was documented as present or absent as seen on standard radiographs.

The final follow-up examination included determination of the AHS score (ankle–hindfoot scale) from the American Orthopaedical Foot and Ankle Society (AOFAS), range of motion evaluation and radiological analysis.

Results

The minimum follow-up was 24 months. Postoperative radiographic analysis confirmed the difficulty of obtaining an anatomical reduction for talar neck or body fractures. Reduction was anatomical in 5 (25%) cases, nearly anatomical reduction in 10 (50%) and poor in 5 (25%).

Early complications included 2 (10 %) superficial wound infections and 1 (5 %) deep infection required surgical irrigation and debridement and appropriate antibiotic treatment. All of

these infections occurred in open fractures. The other complication noted was delayed union in 3 (15 %) patients and was related to persistent infections.

4 (20%) patients presented an osteonecrosis of the talus, among which 3 of them occurred after a talar neck fracture and 1 after body fracture. The radiographic finding of osteonecrosis was made within the first 12 months after injury in 3 cases and within 18 months in all cases. No signs of revascularization were seen despite the non-weight- bearing cast for three to six months.

By the end of final follow-up 5 (25 %) had undergone secondary surgery. 2 (10 %) patients who developed a major collapse of the talar dome underwent tibiotalar arthrodesis between 14 and 19 months. 1 (5 %) patient who had avascular necrosis and persistent subtalar pain underwent tibiotalocalcaneal arthrodesis at 32 months.

At final follow-up, 12 (60%) patients presented post-traumatic osteoarthritis in at least one ankle joint. Subtalar arthritis affected 5 (41.66%) patients, tibiotalar arthritis in 4 (33.3%) and talonavicular arthritis affected 1 (8.33%) patients. 1 (8.33 %) patient developed arthritis of both ankle and subtalar joints. One patient each of talar neck, body and head has undergone arthrodesis of one joint before 30 months of trauma.

1(5 %) patient with an initial lack of reduction required an osteotomy for a serious valgus malunion associated with a subtalar arthrodesis at five months. One patient required an ankle arthrolysis at ten months and another underwent an ankle arthroscopy at 12 months to excise osteochondral fragments.

Hindfoot alignment was not measured in cases of tibiotalar or tibiotalocalcaneal arthrodesis (three patients). At the final follow-up 8 (47.05 %) patients had a normal hindfoot alignment, in 6 (35.29%) patients there was a varus malunion (from 8° of varus to 3° of valgus) and in 3 (17.65 %) cases there was a valgus malunion (10° and 12° of valgus).

Using the AOFAS ankle–hindfoot scale, the average functional score was 69 points (range 43–92 points). The AOFAS score was not significantly different in relation to the fracture type (66.7 for the talar neck fractures and 71.3 for the talar body fractures. Clinical outcome based on ankle-hind foot scoring was rated as excellent in 1 (5 %), good in 10 (50 %), fair in 5 (25 %), and poor in 4 (20 %).

The injured foot demonstrated a significant loss of range of motion compared to the healthy foot for ankle dorsiflexion (6.9° against 16.9°), ankle plantar flexion (24.6° against 33.0°) and subtalar movements (1 point in 7 cases, 2 points in 7 cases and 3 points in 2 cases).

Table 2: Complications and final AHFS score

	Total	Neck	Body	Head	Lateral process	Posterior process
AVN	4	3	1	0	0	0
Mal-union	9	2	3	2	1	1
Non-union	0	0	0	0	0	0
Osteoarthritis	12	5	4	1	2	0
Secondary surgery	5	2	1	1	1	0
Final AHFS	69	66.7	71.3	68.9	67.4	70.7

Table 3: Clinical outcome based on ankle-hind foot scoring.

Grade	No. of patients	Percentage
Excellent	1	5
Good	10	50
Fair	5	25
Poor	4	20

Discussion

The talus takes part in the composition of the ankle, subtalar and talonavicular joints and plays a pivotal role in overall foot function. Because two thirds of the talar surface is covered with articular cartilage, and the blood supply to the talus is vulnerable to injury, once talar fractures happen, neglected or mal-reduced talar fractures may produce a different complication. In 1919, Anderson described for the first time a series of fracture dislocations of the talus after aircraft crashes and described the mechanism of injury. He called this injury aviator's astragalus. In 1952, Coltart collected a larger series after World War II and attempted to classify these fractures and to track their outcomes [15]. Talus fractures result from high-energy trauma to the lower extremities such as motor vehicle accidents or falls from a height [16]. The most commonly proposed mechanisms are an excessive ankle dorsiflexion with a cantilever effect for the talar neck fracture and an axial compressive load for the talar body fractures [4, 7, 12, 1, 17].

The management of these fractures is complex and there is a high complication rate. Displaced talar neck or body fractures are treated conservatively in most cases with very good results. However, for displaced fractures, open reduction and internal fixation is the rule for most authors [11, 18]. The choice of surgical approach depends on the site and classification of talar deformities, as well as soft tissue conditions [19].

Talar body fractures have been associated with a high incidence of complications including osteonecrosis, malunion, nonunion, secondary osteoarthritis, subtalar bony ankylosis, skin infection and skin necrosis. The incidence and severity of these complications appear to relate to several factors including the intrinsic talar vascular supply, the initial extent of displacement, the presence of associated dislocation and the adequacy of reduction [20].

For a better initial reduction, some authors recommend a dual anteromedial and anterolateral approach. This dual approach is sometimes associated with a medial malleolar osteotomy [12, 21]. This technique permits good visualization of the talus but increases the risk of skin necrosis or infection (10-20% depending on authors) and increases the duration of surgery [22, 23].

The surgical delay seems important, and most authors recommend urgent reduction and stabilization of displaced talar fractures [12]. Avascular necrosis is a common complication after talar fractures. In recent papers, the osteonecrosis rate was variable from 11–50% [8, 14, 21, 24]. In 2004, Vallier et al. presented a study where 91% of the talar neck fractures underwent a dual anteromedial and anterolateral approach. At final follow-up, 49% developed avascular necrosis of the talus.

Risk of malunion is a classical complication in this fracture type and is mostly a varus malunion. This risk is mainly influenced by the initial quality of reduction or the fracture type but also by the osteosynthesis technique. For talar neck fractures, Juliano et al. insist on the restoration of the talar length and particularly the medial side; they recommend avoiding compression screwing across an area of comminution at the origin of a talar neck shortening [12]. For talar body fractures, Thor arson recommends the use of neutralization (non-compression) screws for cases with comminution at the fracture site [25]. Some authors prefer plate fixation on the side with the most severe comminution in order to restore the neck length which permits control of the compression in the fracture site [26]. Vallier et al., reporting on radiographic findings of 26 talar body fractures with a minimum follow-up of 1 year, noted a 38% incidence of AVN, 65% incidence of posttraumatic tibiotalar arthritis and 34% incidence of post-traumatic subtalar arthritis. Worse outcomes were noted

in association with comminuted fractures, associated talar neck fractures and open fractures [21].

In this study, we used slightly aggressive operative treatment, and hence obtained fair initial radiological results in comparison with the literature [4, 27]. The lack of good or excellent results may be explained by the exclusion in this study of the displaced fractures because such fractures have an excellent prognosis [6, 12]. Lindvall et al., in 2004, reported on 26 isolated talar neck and body fractures with a minimum follow-up of 48 months and found a 50% incidence of AVN and 100% incidence of posttraumatic arthritis. Timing of fixation did not appear to affect the outcome, union or prevalence of AVN in the later study because the fractures that were stabilized within 6 h did not have a lower incidence of AVN than those stabilized after 6 h. Both of these studies concluded that patients with these injuries should be counseled on the long-term complications and that arthritis is an expected outcome in displaced talar body fractures despite accurate reduction with stable fixation.

The risk of osteoarthritis is high after a talar fracture as majority of the talus has articular cartilage [12]. Arthritis of the ankle and subtalar joint can occur in the absence of osteonecrosis or joint incongruity. Chondral damage can result only from the initial injury or from prolonged immobilization [7]. At long-term follow-up, we observed a very high rate of post-traumatic osteoarthritis (all joints taken together). This arthritis mainly affected the tibiotalar joint and the subtalar joint. Our results may be explained by the high rate of malunion and also by the long follow-up of this study.

Conclusion

The complication rate for talar fractures was high, mostly osteonecrosis and osteoarthritis; these conditions had an impact on the final outcome. The outcome could be improved by better evaluating these fractures with a CT scan, developing dual surgical approaches to best preserve the bone vascular supply and achieve better reduction, and improving the internal fixation hardware, especially the use of plates for comminuted fractures.

Conflict of Interest: Not available

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