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FUNCTIONAL OUTCOMES OF OPERATIVE MANAGEMENT OF TALAR NECK FRACTURE

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Abstract

***Background*:** Fractures of the talus neck necessitate surgery due to the possibility of serious long-term consequences if left untreated. However, given the peculiar anatomy and fragile blood supply, talus fractures can be challenging to fix. The current study was undertaken to analyze the functional outcomes of operative management of talus fractures.

***Material and Method*:** This was a prospective study conducted over a period of 2 years on 20 patients with talus neck fracture. All patients were subjected to open reduction and internal fixation of the fractures with cannulated cancellous screws and followed-up clinically and radiologically.

***Result*:** The average age of the study participants was 33.4±10.0 years. Hawkin's type III was the most frequently encountered talus fracture. The antero-lateral approach had significantly higher AOFAS scores (p=0.005), OM scores (p=0.003), and BJ scores (p=0.004) than the antero-medial and the dual approach. There was a significant co-relation between the Hawkin's type and the AOFAS score (p=0.03), OM score (p=0.04), and BJ score (p=0.02). The incidence of avascular necrosis was significantly higher with type III talar neck fractures (p=0.04) among our study subjects.

***Conclusion*:** The quality of fracture reduction is the only modifiable parameter that can determine the success of the operative treatment in restoring the articular congruence. Although talus fractures should not be deemed as operative emergencies, efforts should be made to restore the articular alignment as soon as possible in order to improve the success rates of the reduction.

Key words: AOFAS score, Complications, Hawkin's classification, Talus fracture

Introduction

Talus fractures make up 0.1% to 2.5% of all fractures and 3% to 5% of foot and ankle fractures, making them relatively uncommon injuries[(1)]. Though rare, talus fractures can be challenging to fix[(2)]. The majority of talus fractures, especially fractures of the body and neck necessitate surgery due to the possibility of serious long-term consequences if left untreated. Given the peculiar anatomy and fragile blood supply, a dislocated talar neck fracture may escalate the risk of avascular necrosis (AVN) of the talar body[(3)].

Successful treatment of such injuries is crucial for regaining function because of talus' function in transmitting force from leg to foot. Operative techniques have improved significantly over the past two decades, so the ideal operational plan is still up for debate. Appraising the functional result and overall wellness in long-run following the surgical treatment of acute talus fractures was the main goal of the current work. Also, the clinical and radiological factors that affected the prognosis of talus fractures were investigated.

Materials and Methods

The present investigation was a prospective study conducted over a period of 2 years from November 2019 to December 2021 with the primary objective of evaluating the long-term functional outcomes of operative management of talus fractures as well as the clinical and radiological variables that impacted the prognosis of talus fractures. Ethical clearance was taken from the Institutional Ethics Committee (IEC/IRB Regd No. ECR/84/Inst/OR/2013/ Appl.No.713) prior to the start of the study. Written informed consent was taken from all the participants before enrolling them into the study and strict confidentiality over relevant patient information was maintained throughout the study. The study was executed in accordance with the principles of the International Council for Harmonization of Technical Requirements for Pharmaceuticals for Human Use-Good Clinical Practice (ICH-GCP) and the Declaration of Helsinki. Patients with a fracture talus presenting to the Department of Orthopaedics, SCB Medical College and Hospital, Cuttack comprised the study population. Patients aged 18 to 60 years, presenting with a closed talar neck fracture were included in the study. Those presenting with compound fractures, fractures neglected for more than 3 months, those having undergone any prior native treatment or who denied consent were excluded from the study.

Each patient underwent a primary assessment and hemodynamic stabilisation at the emergency room. The subsequent secondary survey focused on the presence of additional fractures, the limb's neurovascular condition, and systemic examination. Appropriate anteroposterior radiographs, lateral radiographs, canale view and CT scan (if required) were taken. A below-knee slab was then used to immobilize the limb. The Modified Hawkin's classification[(4)] was used to categorise the talus neck fractures. Preoperative evaluation in the form of a comprehensive clinical examination, thorough haemogram, anteroposterior and lateral view radiographs of the ankle and foot, 3D reconstruction of ankle using CT was done.

All cases underwent open reduction under spinal anesthesia, the patients lying in supine position. Fluoroscopic guidance was offered by means of an image intensifier with a C-Arm. A tourniquet was wrapped around the proximal thigh. After preliminary reduction with K-wire, internal fixation was done with 4-mm partially threaded hollow CC screw. The most frequent technique employed was the anteromedial approach, followed by the anterolateral approach. When subtalar involvement was evident, a combined anteromedial and anterolateral approach was used. The sutures were removed on post-operative day 12. Phase-by-phase mobilisation of the ankle was instructed. In the first six weeks following surgery, patients were instructed to perform active range-of-motion exercises and non-weight bearing crutch ambulation. This would increase the foot's circulation and promote the joint repair. After six weeks, patients were instructed to begin open chain exercises with a band and initiate partial-weight bearing crutch ambulation. Following surgery, the patients were monitored after 1, 3, and 12 months to look for any complications. Post-operative clinical evaluation included gait examination, evaluation of range of motion of the joint, any discomfort, soreness or swelling in the ankle joint. The American Orthopedic Foot and Ankle Society (AOFAS) score[(5)], Olerud-Molander (OM) Ankle Score[(6)], and Baird and Jackson (BJ) score[(7)] were used to assess the final functional

outcome at 12-month follow-up following surgery. Anteroposterior, lateral, and mortise views of the ankle joint were acquired during follow-up x-rays. CT scan was done to see the joint congruity, inspect the reduction and look for any signs of avascular necrosis.
The patient details were collected on a preformed case record form and later entered in Microsoft Excel sheet. All the data were analysed using SPSS v20.0. Descriptive statistics such as mean and standard deviation were used for numerical data. Frequency and percentage were utilised for categorical data. Appropriate statistical tests were applied to deduce conclusions. The results were deemed significant at $p<0.05$.

Observations and Results

A total of 20 patients satisfying the inclusion and exclusion criteria were assessed. Talus fractures were five times more common in men than women in our study. The average age of the study participants who sustained a talus fracture was 33.4±10.0 years. In most cases (55%) the fracture was caused by a fall from height. The average time from injury to operative management was 6.2 ± 4.4 days. According to radiological analysis, Hawkin's type III was the most frequently encountered talus fracture (Table 1).

Age distribution (in years)	
18-30	9 (45%)
31-45	8 (40%)
46-60	3 (15%)
Average age (mean ± SD)	33.4 ± 10.0
Gender distribution	
Male	17 (85%)
Female	3 (15%)
Mode of injury	
Road traffic accident	9 (45%)
Fall from height	11 (55%)
Duration since injury (in days)	
0-2	5 (25%)
3-7	8 (40%)
>7	7 (35%)
Average duration (mean ± SD)	6.2 ± 4.4
Hawkin's classification	
Type I	3 (15%)
Type II	6 (30%)
Type III	8 (40%)
Type IV	3 (15%)

Table 1. Demographic and clinico-radiological characteristics

Antero-medial approach was the most frequently employed approach. All the cases were internally fixed with CC screw. Additionally, a lateral plate was used only in a single case. The patients were timely followed-up to monitor the post-operative progress and look for any complications. The functional outcome was graded using the appropriate scores at 12-months following the procedure (Table 2). The follow-up revealed avascular necrosis in 50% of patients. These patients' complained of discomfort, immobility, and aberrant gait which was corroborated by radiological evidence. Pain and restricted movements at the ankle joint, suggestive of arthritic degeneration were reported in eight (40%) patients. There was a single instance (5%) of non-union at the medial malleolus osteotomy site observed at the third month following surgery. Cancellous screws were chosen as the preferred implants, and none of the patients experienced any implant-related complications such as malalignment.

Approach used	
Antero-medial (AM)	10 (50%)
Antero-lateral (AL)	8 (40%)
Dual approach	2 (10%)
Implants used	
Cannulated cancellous screw	20 (100%)
Lateral plate	1 (5%)
Post-operative AOFAS score	
Excellent (95-100)	0
Good (75-94)	4 (20%)
Fair (51-74)	8 (40%)
Poor (0-50)	8 (40%)
Average AOFAS score	55.8 ± 17.5
Post-operative OM score	
Excellent (≥80)	3 (15%)
Good (65-79)	1 (5%)
Fair (50-64)	8 (40%)
Poor (<50)	8 (40%)
Average OM score	53.3 ± 17.0
Post-operative BJ score	
Excellent (>90)	1 (5%)
Good (61-90)	9 (45%)
Fair (31-60)	8 (40%)
Poor (≤30)	2 (10%)
Average BJ score	57.6 ± 18.6
Complications	
Infection	2 (10%)
Non-union	1 (5%)
Avascular necrosis	10 (50%)
Osteoarthritis	8 (40%)
Total	20

Table 2. Operative parameters and post-operative outcomes

A comparison of the various scores in relation to the approach used revealed that antero-lateral approach had significantly higher AOFAS scores (p=0.005), OM scores (p=0.003), and BJ scores (p=0.004) than the antero-medial and the dual approach. The lowest scores were encountered with the dual approach (Table 3).

	Type of approach of fracture reduction			
	AM approach	**AL approach**	**Dual approach**	**p-value**
Hawkin's types				
Type I	1	2	0	
Type II	3	3	0	0.86[#]
Type III	4	3	1	
Type IV	2	0	1	
AOFAS score	55.1 ± 16.2	61.6 ± 18.3	35.5 ± 3.5	0.005*
OM score	51.5 ± 13.2	61.3 ± 18.4	30.5 ± 3.5	0.003*
BJ score	58.0 ± 15.1	64.0 ± 19.6	30.0 ± 2.8	0.004*

Table 3. Evaluation of outcomes in relation to the approach
Results are significant at p<0.05; *Krushak-Wallis H test; [#]Chi-square test

The talus neck fractures were categorised using Hawkin's classification modified by Canale and Kelly. The radiographical evidence utilised for this classification was a useful tool in predicting the development of post-traumatic AVN following talar neck fracture. There was a significant co-relation between the Hawkin's type and the AOFAS score (p=0.03), OM score (p=0.04), and BJ score (p=0.02). As evidenced, the average functional scores declined with the rising severity of the fracture (Table 4). The type II talar neck fracture had the highest overall scores, whereas type IV had the

lowest. The incidence of AVN was significantly higher with type III talar neck fractures (p=0.04) among our study subjects.

	Hawkin's Classification of Talus Fracture				
	Type I	**Type II**	**Type III**	**Type IV**	**p-value**
AOFAS score	56.3 ± 20.3	66.7 ± 16.9	54.0 ± 13.9	38.0 ± 16.1	0.03*
OM score	58.7 ± 22.0	64.8 ± 17.5	49.1 ± 10.1	36.0 ± 13.9	0.04*
BJ score	64.0 ± 23.6	69.7 ± 15.4	53.0 ± 14.6	39.3 ± 17.9	0.02*
AVN	1	1	7	1	0.04#
Osteoarthritis	1	1	4	2	0.45#

Table 4. Evaluation of outcomes in relation to the type of talus fracture
Results are significant at p<0.05; *Krushak-Wallis H test; #Chi-square test

Discussion

The talus, one of the three bones that make up the ankle joint, serves as a crucial connection between the leg and the foot. It plays an important role in the motion at the ankle joint as well as the subtalar and talonavicular joints located below the ankle. Thus, talus injuries significantly affect the movement at the ankle and foot joints limiting one's ability to walk and bear weight. For optimal results, fractures with major displacement or concomitant dislocation require immediate reduction.

Majority of talar fractures were endured by adult males and the average age of the study subjects was 33.4 ± 10.0 years. A similar male preponderance of talar fractures was observed in earlier research[1,8,9]. Our results were in line with previous studies where the majority of talar fractures were seen in the age group of 26 to 40 years[1,10,11]. However, contrary to our results, another study reported that severe talar fractures were common in pediatric age group, the average age being 13.5 years[12]. Severe talar fractures are extremely rare in children under the age of 12 due to the higher elastic resistance of the immature bone in this age group. The majority of talus fractures are caused by high-energy trauma, such as a vehicle accidents or a fall from a great height. In the present study, fall from height was the leading cause (55%) of sustaining a talar fracture, followed by road traffic accidents (45%). Our findings were consistent with those of Sudharsan et al study where fall from height (FFH) and road traffic accident (RTA) accounted for 52.9% and 47.1% of fracture cases, respectively[13] and contrary to another study where RTA was the major cause (51.9%) of the talar fractures[14]. Talar body fractures are a result of axial compression of a pronated or supinated foot between the tibia and the calcaneum[15]. Talar neck fractures, on the other hand, is caused from forced dorsiflexion of the talus against the tibia in conjuction with a torn subtalar ligament[8].

Non-displaced fractures are managed conservatively and surgical interventions are reserved for high-graded fractures and dislocations[16,17]. In our study, the duration between the injury and the surgery spanned from 2 to 18 days with the average duration being 6.2 ± 4.4 days. The mean time from the injury to the surgical reduction of the talar fractures appears to have little or no effect on the prognosis[18,19], but early intervention and rehabilitation can preserve the soft tissue and neurovascular integrity and offer improved functional outcomes. The extent and pattern of the fracture, soft tissue damage and other associated injuries determine the surgical approach to be performed. Several surgical approaches such as anteromedial approach, posteromedial approach, anterolateral approach, posterolateral approach and dual approach are described for reduction of a talar fracture amongst which the anteromedial approach is the one that is most frequently employed[15]. The anteromedial strategy was the most frequently employed approach in our study as well. However, to achieve a nearly complete anatomical reduction of the fracture, adequate exposure and optimal visualisation of the entire talar neck is a pre-requisite, which is most conveniently provided by a combination of anteromedial and anterolateral (dual) approach[20]. In our study, cannulated cancellous screws were used for the internal fixation of the fracture in all the cases. These screws have the benefit of being simple to put over a guide wire, which lowers the possibility of error and increases precision. A plate adds to the stability of complex fractures. A lateral plate was used only in a single case in our study. The prognosis of the talar fractures is also linked to the Hawkin's classification. The higher severity

types, particularly Hawkins's type III and IV are associated with increased likelihood of developing osteonecrosis[21]. In our study, 8 patients (40%) had Hawkin's type III talar fracture (Table 1) and type III fractures independently had the highest prevalence of AVN in our study (Table 4).
The complete recovery of a talar fracture typically takes 6 to 12 months. We assessed the AOFAS hind-foot score, OM score and BJ Score for all the patients at 12 months post-operatively. Besides the overall score, scores for individual surgical approach (Table 3) and Hawkin's type (Table 4) were also calculated. Although the anteromedial strategy is generally the most sorted after approach and the most employed approach in our study, the average scores were significantly higher with the anterolateral approach. This could possibly be a result of the lower severity grades of the fractures in the anterolateral category as compared to the higher severity grades of the fractures in the anteromedial category (Table 3). In a study by Sharanappa et al.[22] the functional outcome at 12 months were the best achieved with the dual approach of talar fracture reduction. Despite certain major concerns such as excessive soft tissue dissection and vascular disruption, most studies advocate the dual technique over the others[20,23]. In our study, AVN and osteoarthritis were observed in 50% and 40% of the subjects, respectively. Although the functional outcomes were the poorest with type-IV fractures, the incidence of AVN and osteoarthritis were the highest with the type III. Our findings were in agreement with a study by Rey et al.[24], which found that type III Hawkins' was commonly linked with osteoarthritis and AVN, but not with a study by Jordan et al.[25], which found that type IV Hawkins' was most frequently related with osteonecrosis and AVN. Talus receives its blood supply from three main arteries namely posterior tibial, anterior tibial and peroneal arteries (Figure 1). The anterior tibial artery works in conjunction with the perforating peroneal arteries to supply the head and neck of the talus, whereas the posterior tibial artery provides the body. The highest incidence of AVN in type III is due to the fact that all the three major blood supplies are disrupted in this type[26]. Over 90% of the ankle arthritis is secondary in origin, mostly as a result of a traumatic injury or surgical malalignment[27]. Both AVN and osteoarthritis of the talus are terrifying sequelae of talar neck fractures, which is directly proportional to the magnitude of the trauma and the severity of the fracture sustained[28]. In our study, one case of non-union and zero cases of malunion were found. The most frequent causes of nonunion and malunion of the talar body and neck are either incorrectly diagnosed fractures or unsuccessful surgical reductions[29]. According to the most current series of studies, the rate of malunion in talar central fractures treated surgically ranges from 0% to 32.5%[30].

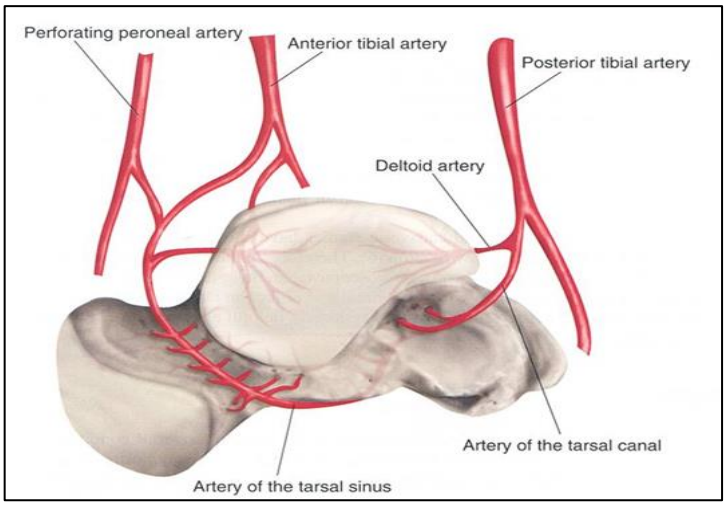

Figure 1. Blood supply to the talus bone.

A significant drawback of the study is that, despite the fact that three significant scores were utilised to assess the functional outcomes in our study, the scoring was only conducted once, at the conclusion of the 12-month period, rather than at each follow-up. Furthermore, a longer follow-up period would be ideal to provide light on a more thorough review.

Talus fractures have a significant enduring impact on the ankle, the hind-foot function and eventually on one's overall well-being. Although talus fractures should not be deemed as operative emergencies, efforts should be made to restore the articular alignment as soon as possible in order to improve the success rates of the reduction.

Figure 2 (a). Pre and post-operative radiographs of talus

Figure 2 (b). Follow-up of the patient at 1 month (centre) and 6 month (right)

Declaration of generative AI and AI-assisted technologies in the writing process: During the preparation of this work the author(s) used QUILLBOT-AI in order to improve the language and grammar. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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