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Treatment of displaced talar neck fractures using delayed procedures of plate fixation through dual approaches

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Abstract

Purpose Treatment of talar neck fractures is challenging. Various surgical approaches and fixation methods have been documented. Clinical outcomes are often dissatisfying due to inadequate reduction and fixation with high rates of complications. Obtaining satisfactory clinical outcomes with minimum complications remains a hard task for orthopaedic surgeons.

Methods In the period from May 2007 to September 2010, a total of 31 cases with closed displaced talar neck fractures were treated surgically in our department. Injuries were classified according to the Hawkins classification modified by Canale and Kelly. Under general anaesthesia with sufficient muscle relaxation, urgent closed reduction was initiated once the patients were admitted; if the procedure failed, open reduction and provisional stabilisation with Kirschner wires through an anteromedial approach with tibiometatarsal external fixation were performed. When the soft tissue had recovered, definitive fixation was performed with plate and screws through dual approaches. The final follow-up examination included radiological analysis, clinical evaluation and functional outcomes which were carried out according to the Ankle-Hindfoot Scale of the American Orthopaedic Foot and Ankle Society (AOFAS), patient satisfaction and SF-36.

Results Twenty-eight patients were followed up for an average of 25 months (range 18–50 months) after the injury. Only two patients had soft tissue complications, and recovery was satisfactory with conservative treatment. All of the fractures healed anatomically without malunion and nonunion, and the average union time was 14 weeks (range 12–24 weeks). Post-traumatic arthritis developed in ten cases, while six patients suffered from avascular necrosis of the talus. Secondary procedures included three cases of subtalar arthrodesis, one case of ankle arthrodesis and one case of total ankle replacement. The mean AOFAS hindfoot score was 78 (range 65–91). According to the SF-36, the average score of the physical component summary was 68 (range 59–81), and the average score of the mental component summary was 74 (range 63–85).

Conclusions Talar neck fractures are associated with a high incidence of long-term disability and complications. Urgent reduction of the fracture-dislocation and delayed plate fixation through a dual approach when the soft tissue has recovered may minimise the complications and provide good clinical outcomes.

Keywords Ankle · Talar neck fracture · Dual approaches · Internal fixation

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Introduction

Talar neck fractures are uncommon but very devastating injuries [1]. They are relatively rare injuries with unique anatomy and tenuous blood supply, and many orthopaedic surgeons have limited experience in managing these fractures and subsequent complications.

Avascular necrosis is one of the most severe complications. Many authors regard fracture displacement and delayed surgery as the key risk factors and recommend immediate open reduction and internal fixation (ORIF) to decrease the incidence of this dreaded complication [2]. However, the high-energy characteristics and associated injuries often make the diagnosis and immediate ORIF difficult; moreover, associated soft tissue damage significantly increases the early soft tissue complications [3].

Screws are used most frequently for fixation of talar neck fractures; however, in cases of comminuted fracture types, they may induce excessive compression [4], so malunion and subsequent osteoarthritis and stiffness of the joint will occur [5].

In this study, urgent reduction of fractures and delayed ORIF were performed with plate and screws through dual surgical approaches. The purpose of this study is to present our experience with plate fixation through dual approaches and assess the clinical outcomes of this protocol.

Materials and methods

Between May 2007 and September 2010, 31 talar neck fractures were treated surgically in our department. Three patients were lost to follow-up and thus excluded from this study. The remaining 28 patients were followed up for an average duration of 25 months (range 18–50 months). There were 21 men and seven women with an average age of 35 years at the time of injury (range 19–64 years). According to the Hawkins classification [3] modified by Canale and Kelly [6], there were 19 Hawkins type II fractures and nine type III fractures. There were no undisplaced (Hawkins type I fracture) or open fractures in this study (Table 1).

Plain radiographs and computed tomography (CT) were performed in order to analyse the fracture pattern, design the surgical plan and evaluate the quality of the fracture reduction after treatment (Fig. 1). Plain radiographs were also performed at each follow-up to evaluate the bone union, malunion, post-traumatic arthritis and avascular necrosis, etc. Post-traumatic arthritis was defined as any loss of joint space, formation of osteophytes or development of subchondral sclerosis or cysts. Avascular necrosis was defined as any area of increased density of the talar dome relative to the adjacent structures [3]. The clinical outcome was evaluated using the Ankle-Hindfoot Scale of the American Orthopaedic Foot and Ankle Society (AOFAS) [7], SF-36 and patient satisfaction [8].

Surgical technique

Under general anaesthesia with sufficient muscle relaxation, urgent closed reduction was initiated immediately; if the procedure failed, open reduction and provisional stabilisation with Kirschner wires through an anteromedial approach with tibiometatarsal external fixation was performed. When the soft tissue had recovered, the definitive procedure was initiated. The patient was positioned supine on a radiolucent operating table with a well-padded pneumatic tourniquet placed on the proximal thigh. General anaesthesia with muscle relaxant was applied to counteract potential muscular deforming forces in the hindfoot. An anteromedial approach extending from the anterior aspect of the medial malleolus to the medial cuneiform

Table 1 Statistical description of the case series ($n=28$ talar neck fractures in 28 patients)

Variable	Result
Sex	
Female	7 (25 %)
Male	21 (75 %)
Age (years)	35 (range 19–64)
Hawkins type	
Type II	19 (67.9 %)
Type III	9 (32.1 %)
Weeks to bony union	14 (range 12–24)
Early complications	
Superficial infection	1 (3.6 %)
Wound dehiscence	1 (3.6 %)
Deep vein thrombosis	1 (3.6 %)
Late complications	
Delayed union	1 (3.6 %)
Avascular necrosis	6 (21.4 %)
Ankle arthritis	3 (10.7 %)
Subtalar arthritis	5 (17.9 %)
Ankle and subtalar arthritis	2 (7.1 %)
Secondary procedure	
Ankle arthrodesis	1 (3.5 %)
Subtalar arthrodesis	3 (10.7 %)
Ankle replacement	1 (3.5 %)
AOFAS hindfoot score	78 (range 65–91)
SF-36	
PCS	68 (range 59–81)
MCS	74 (range 63–85)
Patients' satisfaction	
Very satisfied	8 (28.6 %)
Satisfied	10 (35.7 %)
Average	8 (28.6 %)
Dissatisfied	2 (7.1 %)
Very dissatisfied	None

AOFAS American Orthopaedic Foot and Ankle Society, *PCS* score of the physical component summary, *MCS* score of the mental component summary

was used to expose the fracture and the anteromedial aspect of the talus. An anterolateral approach began at the Chaput tubercle and toward the base of the fourth metatarsal. The extensor retinaculum was sharply incised and the tendons retracted for improved visualisation. Through these dual approaches, length, alignment and rotation of the fractured talus can be corrected and anatomical reduction will be obtained. Kirschner wires were placed across the talar body through the neck into the body to temporarily hold the reduction. The reduction was checked with fluoroscopy. A distal radius plate was contoured to fit the lateral column of the talus, while the distal end of the plate was trimmed to form two sharp hooks in order to

Fig. 1 A 53-year-old male patient with a right ankle injury due to a fall from a 4-m height. Radiographs (**a**, **b**) and CT scan (**c**) revealed a comminuted and displaced talar neck fracture (Hawkins type III) combined with a bimalleolar fracture

facilitate more stable fixation of the talar head. The plate was secured to the talus with 2.7-mm screws. As a supplement, one or two cannulated screws were placed from the talar head into the body in the medial column of the talus. Care should be taken to countersink the screw head to minimise irritation of the joint. Final fluoroscopic anteroposterior, lateral and Canale views of the ankle were obtained to confirm reduction. The wound was closed in layers over a drain.

Post-operative management

A well-padded splint was used in ankle neutral alignment until the wound had healed. The drain was removed after 24 hours. Ankle motion and physiotherapy were initiated after splint removal. Progressive weight-bearing was allowed after six to eight weeks, depending on radiological evidence of early union. Partial weight-bearing lasted for about 12 weeks. Anteroposterior and lateral radiographs and CT were routinely performed immediately after surgery. Serial radiographs were performed three weeks, six weeks, nine weeks, six months and 12 months post-operatively (Fig. 2).

Results

Anatomical reduction and alignment were obtained in all cases. One patient developed wound dehiscence and another patient had superficial infection; both were treated successfully with conservative management. One patient who sustained a concomitant pelvic fracture presented with deep vein thrombosis and recovered with medical treatment.

At final follow-up, all patients obtained fracture union; the average union time was 14 weeks (range 12–24 weeks). One patient had a delayed union and obtained bony union 24 weeks after surgery. Three patients presented with post-traumatic osteoarthritis in the ankle joint, while five patients had subtalar joint arthritis and two patients had ankle and subtalar arthritis. Six patients suffered from avascular necrosis of the talus, and revascularisation of the talar dome was detected in two cases on radiographs. Three of the other four patients had no subjective symptoms, and one patient needed a secondary procedure.

Secondary procedures included three cases of subtalar arthrodesis, one case of ankle arthrodesis and one case of total

Fig. 2 After urgent closed reduction and provisional stabilisation with tibiometatarsal external fixation, radiographs (**a**, **b**) showed a rough reduction of displacement and alignment. Two weeks later, when the soft tissue had recovered, definitive ORIF was performed. Radiographs (**c**, **d**) showed that anatomical reduction and alignment had been obtained. The subtalar joint was fixed by a Kirschner wire for 6 weeks, and the rupture of the anteroinferior tibiofibular ligament was fixed by a rivet. Twelve weeks later, CT scans (**e**, **f**) showed bony union without malunion and avascular necrosis of the talar body


ankle replacement. After a mean follow-up duration of 25 months (range 18–50 months), the mean AOFAS hindfoot score was 78 (range 65–91); 54 % (15/28) achieved excellent, 25 % (7/28) good, 14 % (4/28) fair and 7 % (2/28) poor post-operative scores. The average pain score was 33, function score was 36 and the alignment score was 9.

SF-36 was used for assessing the physical and mental health status of the patients. At the final follow-up, the average score of the physical component summary was 68 (range 59–81), and the average score of the mental component summary was 74 (range 63–85). According to patients' satisfaction, 18 patients were very satisfied or satisfied and returned to their pre-injury employment. Satisfaction was average in eight, two were dissatisfied with their procedures and no one was very dissatisfied (Fig. 3).

Discussion

Talar fractures are relatively rare injuries and comprise less than 0.5 % of all fractures, while approximately half of all talar fractures are talar neck fractures [9]. The talus has seven

articular surfaces with about two thirds of the surface covered by articular cartilage, so it plays a very important role in the
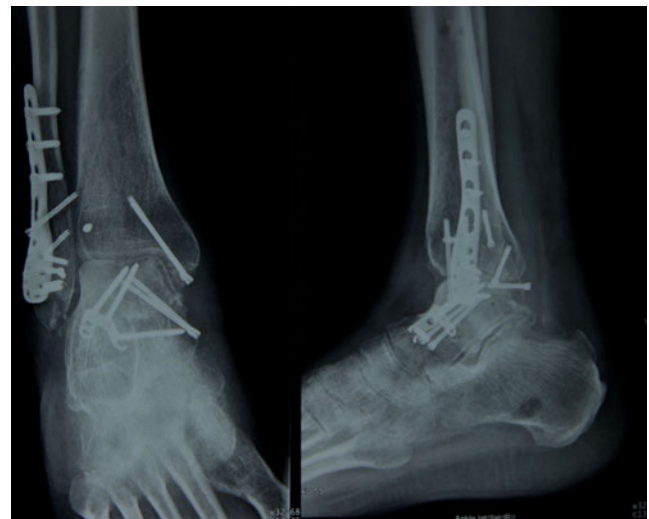
Fig. 3 Three years later, radiographs showed slight degenerative changes of the ankle and subtalar joint without avascular necrosis of the talar body. The patient was very satisfied with the procedures, and the AOFAS ankle-hindfoot score was 91 points

function of the foot and ankle. A high percentage of fractures to this bone are intra-articular [10]. The vascular anatomy of the talus has been well studied [11, 12]. The blood supply to the talus is rich; however, most of the vessels enter the head of the talus and supply the body in a retrograde manner, so the blood supply to the talar body is vulnerable and carries a very high risk of avascular necrosis with displaced fractures. The incidence frequently coincides with the severity of the injuries and ranges from 0–15 % in Hawkins type I fractures to 69–100 % in type III and IV fractures [13, 14]. Many studies regard fracture displacement and delayed surgery as the key risk factors and recommend immediate ORIF to decrease the incidence of this dreaded complication. However, talar neck fractures are commonly caused by high-energy injuries, associated injuries and systemic trauma and may delay diagnosis and formal ORIF of the fractures. Furthermore, severe soft tissue damage makes urgent definitive treatment difficult with increased early complications. Skin necrosis, wound dehiscence and infection are the common early complications and sometimes very troublesome to treat [15]. Metzger et al. considered that the development of avascular necrosis is almost completely determined at the time of injury [13]. Elgafy et al. also agreed that proper surgical techniques and anatomical reduction cannot necessarily stop displaced talar neck fractures from developing avascular necrosis [16]. So it may be impossible to prevent avascular necrosis resulting from rupture of the tenuous blood supply in grossly displaced talar neck fractures. Some authors have recommended urgent closed reduction of fracture displacement and open injury, followed by delayed definitive surgery for ORIF, comparable to the staged treatment of high-energy pilon fractures [16–18]. In this study, delayed procedures for definitive ORIF were used to minimise the soft tissue complications and win sufficient preparation time to deal with these complex injuries.

Malunion can result in incongruity and degenerative arthritis in the ankle and subtalar joints and has been reported to be approximately 30 % [19]. The most common malunion is varus malalignment caused by inadequate realignment of the medial talar neck and an incorrect osteosynthesis technique [20]. Many studies have demonstrated that the main reason for poor outcomes is post-traumatic arthritis, which is dependent on malunion and damage to the cartilage at the time of injury [15, 20, 21]. Anatomical reduction is difficult to obtain owing to the complex anatomy of the talus and comminuted nature of the fractures [8]. A dual approach can provide better control during reduction because the medial and lateral faces of the talar neck are exposed, so many surgeons recommend dual approaches to obtain anatomical reduction and axial alignment [15, 22, 23]. The effect of dual approaches on the blood supply is still unknown. Some studies have suggested it can deteriorate the already damaged soft tissue and bloody supply of the talar body [24]. But the authors believe some advantages can be obtained in preservation of the residual arterial supply of the talus because both of these two approaches use the interval between the neurovascular bundle. Furthermore, adequate exposure can be achieved from dual approaches without forceful manipulation of the soft tissue [4].

Fleuriau Chateau et al. presented minifragment plates for fixation of talar neck fractures and concluded that the technique was useful to maintain anatomical reduction and decrease the chance of varus malunion [25]. Vallier et al. used minifragment plates for the treatment of talar neck fractures and found 49 % of patients presented with radiographic evidence of osteonecrosis, while 37 % of these cases demonstrated revascularisation of the talar dome without collapse [15]. In this study, the trimmed distal radius plate and medial screws were applied to gain rigid internal fixation. The configuration of the distal radius plate can match the anatomical shape of the talus very well. Stable fixation is essential for revascularisation by preventing shearing force across the fracture site [15, 25]. This can also allow for early motion of the ankle and subtalar joints, potentially minimising post-traumatic arthritis caused by immobilisation. There was no malunion in this study. This is because dual approaches were used allowing initial anatomical reduction; furthermore, by providing longitudinal structural support and preventing rotation of the distal fragment, plate fixation can maintain the initial reduction until bony union.

In conclusion, urgent reduction of fracture displacement and delayed plate fixation through a dual approach when the soft tissue has recovered can minimise the soft tissue complications without increased incidence of avascular necrosis of the talar body. The modified distal radius plate placed on the lateral column combined with medial column neutralisation screw fixation through dual approaches can obtain anatomical reduction, rigid fixation and early rehabilitation, allowing optimal clinical outcomes with a low rate of complications.

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Author contributions