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LONG-TERM FOLLOW UP OF TALUS FRACTURES

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ABSTRACT

Eighty-six patients who had experienced a fracture of the talus more than 10 years previously were assessed. The fracture had occurred in the neck of the talus in 52 feet and in the body of the talus in 27 feet. The fracture was complicated by dislocation in 47 feet, and aseptic necrosis had developed in 33 feet. The outcome was rated as excellent in 20 feet, good in 43, fair in 18, and poor in 7. The cause of poor outcome in the late stage was posttraumatic osteoarthritis secondary to avascular necrosis and incongruity of the joint surface. Early active exercise without weight bearing is recommended to prevent contracture and bone atrophy due to disuse, which may promote osteoarthritis. Arthrodesis is recommended in patients with pain because the outcome is greatly improved by arthrodesis, even when performed more than 10 years after the injury.

Because 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. The high incidence of avascular necrosis after fracture-dislocations increases the likelihood of a poor outcome, as does incongruity of

the articular surface after intraarticular fractures.¹ However, the long-term outcome remains unclear, as there has been no reported large series that examines the results of treatment over time.

MATERIALS AND METHODS

Two hundred twenty major fractures of the talus were treated at Keio University Hospital between 1970 and 1990, 112 of which were treated more than 10 years after injury. Of these 112 patients, we were able to examine 86, 70 in males and 16 in females. The mean age at the time of injury was 26.4 years (range: 8 to 63); the mean follow-up period was 14.9 years (range: 10 to 21). The right foot was injured in 49 patients, the left in 35, and both feet in 2. The fracture was open in 17 cases. Fractures of the neck of the talus occurred in 52 feet, fractures of the body in 27 feet following a classification similar to Canale, and fractures at other sites in the talus in 9 feet. No dislocation (Type 1) occurred in 41 feet, dislocation of the subtalar joint (Type 2) occurred in 7 feet, dislocation of both the subtalar and ankle joints (Type 3) occurred in 35 feet, dislocation of the subtalar, ankle, and talonavicular joints (Type 4) occurred in 3 feet, and other dislocations (Type 5) occurred in 2 feet (Table 1). In addition to the talus fracture, additional ipsilateral ankle fracture occurred in 8 cases, ipsilateral calcaneus fracture in 15 cases, and other fractures in 20 patients.

Open reduction and internal fixation (ORIF) was performed for 38 fracture-dislocations, manual reduction and external fixation for 8 fracture-dislocations, and external fixation alone for 40 fractures not associated with dislocation (Type 1). The average duration of plaster

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Table 1

FRACTURE DISLOCATIONS OF THE TALUS				
Dislocation Site	Fracture Site			Total (Feet)
	Neck	Body	Other	
None (Type 1)	23	10	8	41
Subtalar (Type 2)	5	2	0	7
Subtalar + ankle (Type 3)	20	15	0	35
Subtalar + ankle + talonavicular (Type 4)	3	0	0	3
Other (Type 5)	1	0	1	2
Total	52	27	9	88

Table 2

ASEPTIC NECROSIS/FRACTURE DISLOCATION OF THE TALUS				
Dislocation	Fracture Site			Total (Feet)
	Neck	Body	Other	
Type 1	4 (17%)	1 (10%)	0 (0%)	5 (12%)
Type 2	2 (40%)	1 (50%)	0 (0%)	3 (43%)
Type 3	11 (55%)	7 (47%)	0 (0%)	18 (51%)
Type 4	3 (100%)	0 (0%)	0 (0%)	3 (100%)
Type 5	1 (100%)	0 (0%)	0 (0%)	1 (50%)
Total	21 (40%)	9 (33%)	0 (0%)	30 (34%)

cast immobilization was 3.2 weeks when treated by ORIF and 6.3 weeks when treated by external fixation. Avascular necrosis was diagnosed on the basis of Hawkins' sign from 6 to 8 weeks after injury, and occurred in 30 feet (Table 2). In these patients with avascular necrosis, non-weight bearing with a patellar tendon bearing (PTB) brace was continued until revascularization was completed or until 3 years had passed. However, early active exercise was recommended immediately after removing the cast.

Arthrodesis was performed as a secondary operation in 18 feet (arthrodesis of the ankle in 10, subtalar arthrodesis in 6, and both in 2).

RESULTS

The clinical outcome was assessed according to Hawkins' criteria (Table 3), and rated as excellent, good, fair, or poor. The rating was excellent in 20 cases, good in 43, fair in 18, and poor in 7 (Table 4). The outcome was assessed as excellent or good in all Type 1 injuries, but as fair or poor in more than a half of Type 2 to 5 injuries. The outcome was particularly poor in all Type 4 fracture dislocations. There was no significant difference in outcome between neck fracture and body fracture (Table 5). No patient who developed avascular necrosis had an excellent outcome, regardless of the type of dislocation or fracture. Sixty-seven percent of patients with avascular necrosis were assessed as fair or poor (Table 6).

Table 3

HAWKIN'S CRITERIA FOR CLINICAL OUTCOME	
Criteria	Points Assigned
Pain	
None	5
After activity	3
Continuous	0
Limp	
Absent	3
Present	0
ROM: Ankle	
Full	3
Limited	2
Fused	1
Fixed Deformity	0
ROM: Subtalar	
Full	3
Limited	2
Fused	1
Fixed Deformity	0
Rating	Total Scores
Excellent	15-13
Good	12-10
Fair	9-7
Poor	6-0

CASE EXAMPLES

Case 1. A 20-year-old woman was injured in a motorcycle accident in 1972. She sustained an open Type 4 fracture of the neck of the talus, and dislocations of the subtalar, ankle, and talonavicular joints (Fig 1). The treatment was initiated with open reduction and temporary fixation with a Kirschner wire. Internal fixation with screws was delayed for 3 weeks because of skin necrosis and the risk of infection. Although reduction was adequate, not unexpectedly, avascular necrosis occurred, and the patient was kept non-weight bearing with a PTB brace for 2½ years. At this time, she was gradually allowed to bear more weight, as the radiographic density of the talus appeared to approximate that of the surrounding bones. However, the body of the talus collapsed 3 years after the injury (Fig 2). This was associated with significant pain, and was treated with removal of the entire talus and a tibiocalcaneal arthrodesis. Three years following arthrodesis the patient did not complain of any pain, and her clinical score was 11 points (a good outcome) (Fig 3).

Case 2. A 24-year-old man was injured in a motorcycle accident in 1983. He had a Type 1 undisplaced fracture of the talus. However, the body of the talus was crushed and the calcaneus was fractured. Open reduction and internal fixation were performed; however, adequate anatomical reduction of the joint surface could not be achieved. Three years after the injury the

Table 4

CLINICAL OUTCOME															
Dislocation	Neck					Fracture Site					Body				
	E	G	F	P	T	E	G	F	P	T	E	G	F	P	T
Type 1	9 (39%)	14 (61%)	0 (0%)	0 (0%)	23	3 (30%)	7 (70%)	0 (0%)	0 (0%)	10					
Type 2	1 (20%)	3 (60%)	1 (20%)	0 (0%)	5	0 (0%)	1 (50%)	1 (50%)	0 (0%)	2					
Type 3	1 (5%)	9 (45%)	10 (50%)	0 (0%)	20	1 (7%)	6 (40%)	4 (27%)	4 (27%)	15					
Type 4	0 (0%)	0 (0%)	0 (0%)	3 (100%)	3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0					
Type 5	0 (0%)	0 (0%)	1 (100%)	0 (0%)	1	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0					
Total	11 (21%)	26 (50%)	12 (23%)	3 (6%)	52	4 (15%)	14 (52%)	5 (19%)	4 (15%)	27					
Dislocation	Other					Total (Feet)									
	E	G	F	P	T	E	G	F	P	T					
Type 1	5 (63%)	3 (38%)	0 (0%)	0 (0%)	8	17 (41%)	24 (59%)	0 (0%)	0 (0%)	41					
Type 2	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	1 (14%)	4 (57%)	2 (29%)	0 (0%)	7					
Type 3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	2 (6%)	15 (43%)	14 (40%)	4 (11%)	35					
Type 4	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0	0 (0%)	0 (0%)	0 (0%)	3 (100%)	3					
Type 5	0 (0%)	0 (0%)	1 (100%)	0 (0%)	1	0 (0%)	0 (0%)	2 (100%)	0 (0%)	2					
Total	5 (56%)	3 (33%)	1 (11%)	0 (0%)	9	20 (23%)	43 (49%)	18 (20%)	7 (8%)	88					

E=excellent
G=good
F=fair
P=poor
T=total

patient had stiffness and pain with a poor outcome and a Blair-type tibio-talar arthrodesis was performed (Fig 4). The patient walks without a limp, is not complaining of pain 12 years after the injury, and had a score of 11 points (good outcome).

DISCUSSION

Coltart² classified major fractures of the talus according to anatomical site: head, neck, and body. Hawkins³ classified fracture-dislocations into three types and reported a correlation between avascular necrosis of the body of the talus and fractures of the neck of the talus associated with dislocations. In Hawkins' classification, Type 1 fractures are not associated with dislocation, Type 2 are fractures with subtalar dislocation, and Type 3 are fractures associated with both ankle and subtalar dislocations. Canale and Kelly⁴ added associated talonavicular dislocations to Hawkins' classification as "Type 4." We have used Hawkins' classification, and have added a "Type 5" to categorize other dislocations or combinations of dislocations that do not fit into Types 1 to 4.

We previously classified fractures of the talus anatomically into those of the neck, body and other patterns; those of the head, sagittal fractures, and those of the lateral process are included in "other fractures."⁵ While the definition of a fracture of the talar neck sounds simple, it is difficult to define the border of the neck,

Table 5

CLINICAL OUTCOME					
Dislocation	Excellent	Good	Fair	Poor	Total (Feet)
Type 1	17 (41%)	24 (59%)	0 (0%)	0 (0%)	-41
Type 2	1 (14%)	4 (57%)	2 (29%)	0 (0%)	7
Type 3	2 (6%)	15 (43%)	14 (40%)	4 (11%)	35
Type 4	0 (0%)	0 (0%)	0 (0%)	3 (100%)	3
Type 5	0 (0%)	0 (0%)	2 (100%)	0 (0%)	2
Total	20 (23%)	43 (49%)	18 (20%)	7 (8%)	88
Fracture Location					
Neck	11 (21%)	26 (50%)	12 (23%)	3 (6%)	52
Body	4 (15%)	14 (52%)	5 (19%)	4 (15%)	27
Other	5 (56%)	3 (33%)	1 (11%)	0 (0%)	9
Total	20 (23%)	43 (49%)	18 (20%)	7 (8%)	88

because there are no clear landmarks on radiographs except the anterior margin of the trochlea. Moreover, neck fractures and body fractures overlap at the anterior margin of the trochlea. We therefore focused on the lower surface of the talus, where fractures are separated clearly by the lateral process, and we classified neck fractures and body fractures in the manner described previously.

During the initial 2 years following injury, the main reasons for poor outcome were avascular necrosis, incongruity of the joint, disuse bone atrophy, and contractures.⁶ These lesions caused osteoarthritis of the subtalar and fibiotalar joints; however, more than 10 years after the

Table 6

CLINICAL OUTCOME (AN VS NOAN)													
Dislocation	Excellent		Good		Fair		Poor		Total		Total		Total (feet)
	AN	noAN	AN	noAN	AN	noAN	AN	noAN	AN	noAN	AN	noAN	
Type 1	0 (0%)	17 (47%)	5 (100%)	19 (53%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5	36	41
Type 2	0 (0%)	1 (25%)	1 (33%)	3 (75%)	2 (67%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (29%)	3	4	7
Type 3	0 (0%)	2 (12%)	4 (22%)	11 (65%)	11 (61%)	3 (18%)	3 (17%)	1 (6%)	4 (11%)	14 (40%)	18	17	35
Type 4	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	3 (100%)	0 (0%)	3	0	3
Type 5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)	1	1	2
Total	0 (0%)	20 (34%)	10 (33%)	33 (57%)	14 (47%)	4 (7%)	6 (20%)	1 (2%)	7 (8%)	18 (20%)	30	58	88
Fracture Location													
Neck	0 (0%)	11 (35%)	7 (33%)	19 (61%)	11 (52%)	1 (3%)	3 (14%)	0 (0%)	3 (6%)	12 (23%)	21	31	52
Body	0 (0%)	4 (22%)	3 (33%)	11 (61%)	3 (33%)	2 (11%)	3 (33%)	1 (6%)	4 (15%)	5 (19%)	9	18	27
Other	0 (0%)	5 (56%)	0 (0%)	3 (33%)	0 (0%)	1 (11%)	0 (0%)	0 (0%)	0 (0%)	1 (11%)	0	9	9
Total	0 (0%)	20 (34%)	10 (33%)	33 (57%)	14 (47%)	4 (7%)	6 (20%)	1 (2%)	7 (8%)	18 (20%)	30	58	88 feet

AN=aseptic necrosis

Fig 1: Case 1. A 20-year-old woman. Hawkins' Type 4 fracture-dislocation.

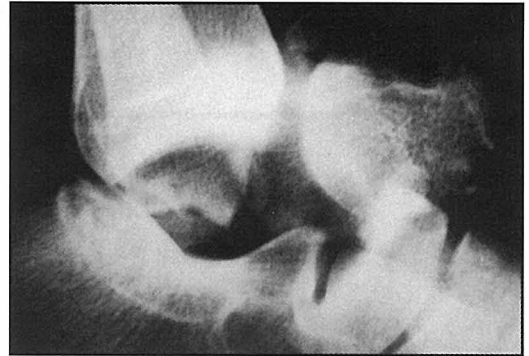
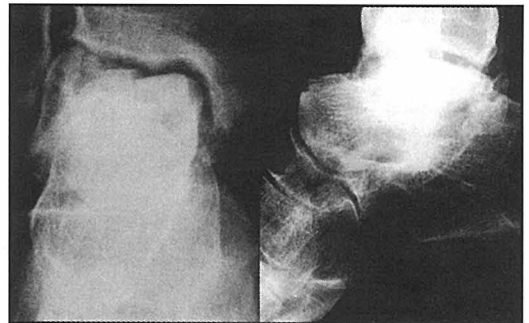


Fig 2: Case 1. Three years after the injury. The trochlea collapsed as a result of aseptic necrosis.



injury, osteoarthritis became the main reason for poor outcome. The more severe the osteoarthritis was at this late stage, the worse the outcome became.

Muscle atrophy and contractures should be prevented by early cast removal and active exercise without weight bearing; we recommend that the cast be removed 3 weeks following injury. Anatomic reduction and rigid internal fixation can make it possible to begin this early motion and are essential to a good outcome. Avascular necrosis was diagnosed on the basis of Hawkins' sign 6 weeks after the injury followed by patchy lucency and sclerosis a few months later. Mulfinger and Trueta⁷ reported that the body of the talus is fed mainly by arteries along the interosseous ligament, and that they are ruptured by subtalar dislocation. Avascular necrosis is almost completely determined at the time of the injury, although prompt reduction of the dislocation has been recommended to decrease the likelihood of this occurrence.

Many treatments, including primary subtalar arthrodesis, have been attempted to promote recovery of the blood supply, but none has proved effective. Although we recommend non-weight bearing for up to 3 years to prevent late collapse associated with avascular necrosis,⁸ this is quite controversial. Healing of the fracture is not affected by disruption of the blood supply, and

many authors recommend initiation of weight bearing once radiographic evidence of healing is present. In our series, revascularization of the talus occurred as late as 3 years following injury; we therefore recommend, whenever feasible, restricted weight bearing up to this time. Intraarticular malunion persists as incongruity of the joint surface and causes osteoarthritis. The neck of the talus has no joint surfaces. However, the displacement at the neck, as well as at the body and head, may cause incongruity of the joint surface, because the anterior and middle subtalar joints and posterior subtalar joint move as one unit. Interestingly, the clinical results become stable more than 10 years after the injury, regardless of the initial outcome. Arthrodesis may be necessary if the pain persists at this stage, and may be limited to the ankle joint, but in many cases, a tibiotalocalcaneal arthrodesis is necessary. The results were markedly improved by arthrodesis, even when more than 10 years had passed since the injury. Blair's method of arthrodesis is recommended when avascular necrosis is present, because some movement between the head of the talus and the calcaneus remains after removing the body of the talus.^{9,10}

CONCLUSION

The main cause of poor outcome more than 10 years after injury is osteoarthritis deformans at the subtalar, ankle, and talonavicular joints. Early exercise without weight bearing and anatomical reduction at the neck, as well as at the head and the body in the early stage, prevents late osteoarthritis. Avascular necrosis is associated with a poor outcome, and arthrodesis is recommended when the patient complains of pain, even when more than 10 years have passed since the injury.

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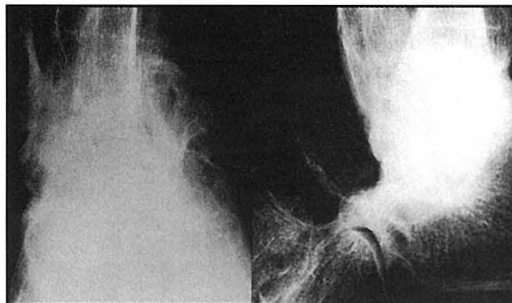


Fig 3: Case 1. Eleven years after the injury and 3 years after arthrodesis. The tibia and calcaneus were directly fused.



Fig 4. Case 2. A 24-year-old man. Blair's arthrodesis was completed 11 years after the injury.

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