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FRACTURE OF THE NECK OF THE TALUS

A Clinical Study

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A clinical evaluation of 46 patients treated for fractures of the neck of the talus has been made after a mean follow-up period of 6 years. The cause of injury was most frequently motor vehicle accidents (26) and falls from heights (11). In non-displaced fractures plaster with immobilization was used and displaced fractures were treated by closed or open reduction. At follow-up most of the patients complained of symptoms hampering daily activities. Objectively, excellent to good results were obtained in 75 per cent of the non-displaced fractures and in 42 per cent of the displaced. Delayed union occurred in 15 per cent. Avascular necrosis was found in 15 per cent and degenerative changes in 97 per cent. A decreased density of bone under the articular cartilage, called subchondral atrophy, was seen in 50 per cent.

Key words: fractures; talus; treatment; follow-up

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Fractures of the talus occur in aviation and motor vehicle accidents, in falls from heights and as a result of falling objects (Anderson 1919, Miller & Baker 1939, McKeever 1963, Coltart 1952, Mindell et al. 1963, Kenwright & Taylor 1970, Hawkins 1970, Sneppen & Buhl 1974). These fractures can involve the whole of the talus with comminution and displacement or the restoration of function of the limited only to the neck of the talus. In this case the fracture may be either non-displaced or displaced.

The simple fracture without displacement of the neck of the talus seldom presents any problems as regards treatment or the restoration of function of the foot. The displaced fracture, however, poses difficulties regarding the immediate treatment and may also impair the future function of the foot depending on whether or not avascular necrosis develops.

Non-displaced fractures

The majority of these fractures are treated initially by immobilization in plaster until radiological union has been demonstrated (Miller & Baker 1939, Boyd & Knight 1942, McKeever 1963, Coltart 1952, Mindell et al. 1963, Kenwright & Taylor 1970).

Avascular necrosis as a late complication has been encountered occasionally, e.g., in 2 per cent as reported by Brinkmann et al. (1973). Otherwise the results are reported to be excellent to good.

Displaced fractures

Coltart (1952) suggested an accurate reduction by closed or open means for displaced fractures which also has been

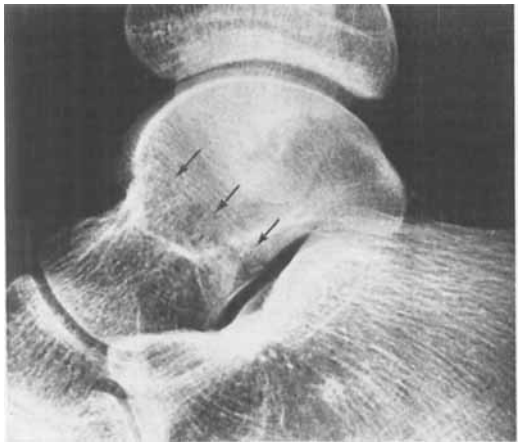


Figure 1. Vertical fracture of the neck of the talus without displacement. (Hawkins Group I). Black arrows indicate fracture.

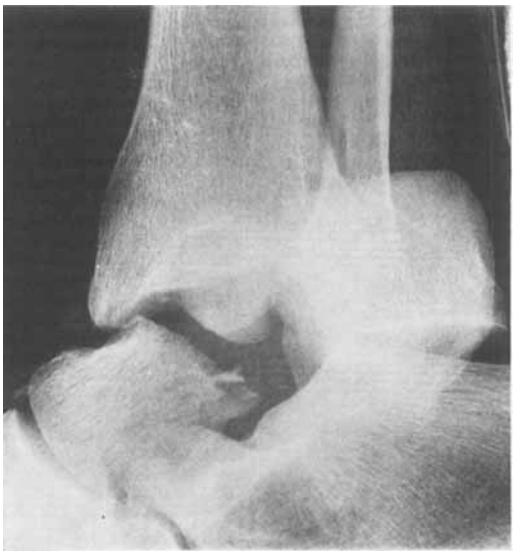


Figure 2. Vertical fracture of the neck of the talus with displacement of the body from the subtalar joint. (Hawkins Group II).

advocated by Boyd & Knight (1942) and McKeever (1963). Later studies support this view (Kenwright & Taylor 1970, Hawkins 1970).

According to Kenwright & Taylor (1970) the prognosis for displaced fractures is much better when an acceptable initial reduction has been achieved.

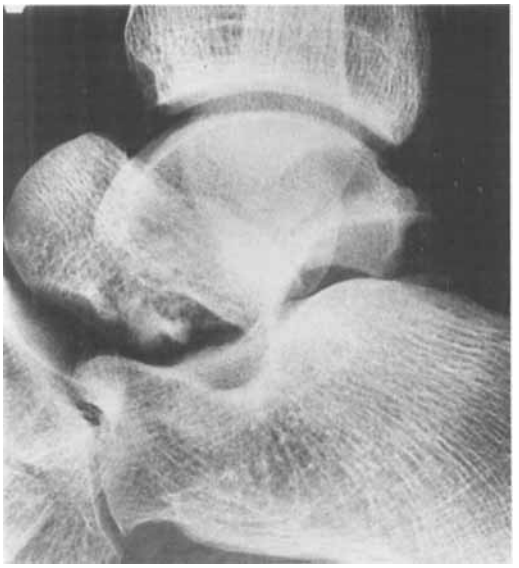


Figure 3. Vertical fracture of the neck of the talus with displacement of the body from both the talocrural and subtalar joints. (Hawkins Group III).

Avascular necrosis as a late complication can occur in about 60 per cent of cases (Hawkins 1970). Once established, the treatment varies; conservative measures have been suggested by Mindell et al. (1963).

Classification

Various classifications have been put forward. The most accepted is that of Hawkins (1970) which is as follows:

Group I – Vertical fracture of the neck of the talus without displacement (Figure 1).

Group II – Vertical fracture of the neck of the talus with displacement of the body from the subtalar joint but not from the talocrural joint (Figure 2).

Group III – Vertical fracture of the neck of the talus with displacement of the body from both the subtalar and talocrural joints (Figure 3).

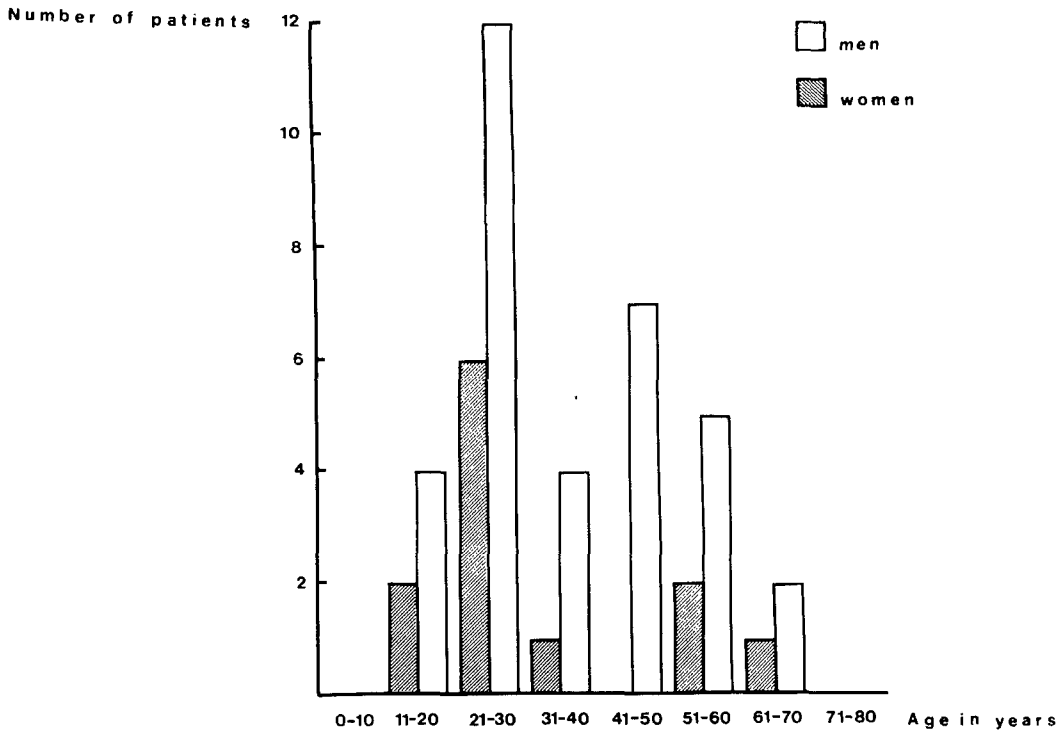


Figure 4. The distribution of age and sex at the time of injury in 46 patients with fracture of the neck of the talus.

PATIENTS AND METHODS

The following clinical investigation was carried out: 1) to report on a material of patients treated during the years 1960–1972 for fracture of the neck of the talus; 2) to make a clinical evaluation of this material with a mean follow-up time of 6 years (1 year 4 months–13 years 4 months); 3) to make a radiological assessment of late results and 4) to correlate if possible the clinical impressions with experimental observations (Peterson & Goldie 1975).

The material consisted of patients who were treated for fracture of the neck of the talus from 1 January 1960 until 31 December 1972. Forty-six patients were collected.

Table 1. Cause of injury in 46 patients with fracture of the neck of the talus.

Injury	Men	Women	Total
Traffic	15	11	26
Fall from a height	10	1	11
Athletics	4	0	4
Falling objects	5	0	5
Total	34	12	46

Table 2. Classification according to Hawkins (1970) of 46 fractures of the neck of the talus.

Sex	Classification I	II	III	Total
Men	9	18	7	34
Women	4	4	4	12
Total	13	22	11	46

The distribution of age and sex at the time of injury is shown in Figure 4.

There were four main causes of injury (Table 1): Traffic accidents, falls from heights, athletic accidents, injury from falling objects.

The classification of the fractures is seen in Table 2 and their relation to cause in Table 3.

Associated injuries are presented in Table 4.

The treatment is presented in Table 5 and related to the classification.

Only two local complications were registered and these were wound infections.

Table 3. Type of accident causing fracture of the neck of the talus in 46 patients.

Type of accident	Classification (Hawkins) I	II	III	Total accidents	
Motorcar driver	3	5	6	14	
Motorcar passenger	2	1	1	4	
Motorcycle driver	1	3	–	4	
Motorcycle passenger	1	–	–	1	
Pedestrian	–	2	–	2	
Bicycle	–	1	–	1	26
Fall from a height	3	6	2		11
Athletics	2	1	1		4
Falling object	1	3	1		5
Total	13	22	11		46

Table 4. Associated injuries in 25 out of 46 patients with fracture of the neck of the talus.

Injury	Classification (Hawkins) I	II	III	Total injuries
Skull	1	4	1	6
Upper extremity	2	1	–	3
Same lower extremity	4	8	6	18
Other lower extremity	4	3	–	7
Soft tissue	–	2	–	2
Total	11	18	7	36

Table 5. Treatment in 46 patients with fracture of the neck of the talus.

Treatment	Classification (Hawkins) I	II	III	Total
Non-weight-bearing, no immobilization	–	1	–	1
Immobilization in plaster	13	3	–	16
Closed reduction + immobilization in plaster	–	8 *	6	14
Open reduction + immobilization in plaster	–	4	4	8
Open reduction + internal fixation + immobilization in plaster	–	6	1	7
Total	13	22	11	46

* percutaneous transfixation in 1 patient.

Follow-up

All patients were contacted by letter and by telephone, and 42 were traced, of whom six could not be examined for various reasons. Thus 36 patients, 28 men and 8 women, were included in the follow-up.

The period of observation varied from 1 year and 4 months to 13 years and 4 months with a mean of 6 years (Figure 5).

A questionnaire was sent to the patients and once returned the clinical examination was carried out. Questions regarding various aspects of foot function, pain and gait had to be answered.

The patients were questioned especially with regard to possible change of work because of the foot injury; the need for special shoes, foot supports and walking aids. The following was registered: gait with special reference to limping; range of motion in talocrural and subtalar joints; circumference of the lower leg and around the malleolae; instability of the ankle joints.

All radiographs from the primary and later examinations and clinical follow-up were studied. Anteroposterior projections were taken of each ankle and lateral projections with a maximum of active plantar and dorsal flexion in order to detect subluxation of the ankle joint. All patients were examined under non-weight-bearing conditions and both talocrural and subtalar joints were always examined under identical conditions.

Suitable exposure data were chosen in order to be able to judge optimally the architecture of the bone trabeculae of the talus and surrounding bones. A special film with a high silver content (Kodak Industrex) was of great value for this investigation.

Possible displacement of subluxation of the ankle and the subtalar joints were noted as well as the appearance of the tibial edges.

Degree of reduction was estimated.

From the series of films of each patient an attempt was made to judge the time of healing, the appearance of sclerosis, and also subchondral atrophy, which is a new concept based on the observation that a thin zone of lessened bone density can appear under the articular cartilage.

The articulations of the talus were judged by the following criteria:

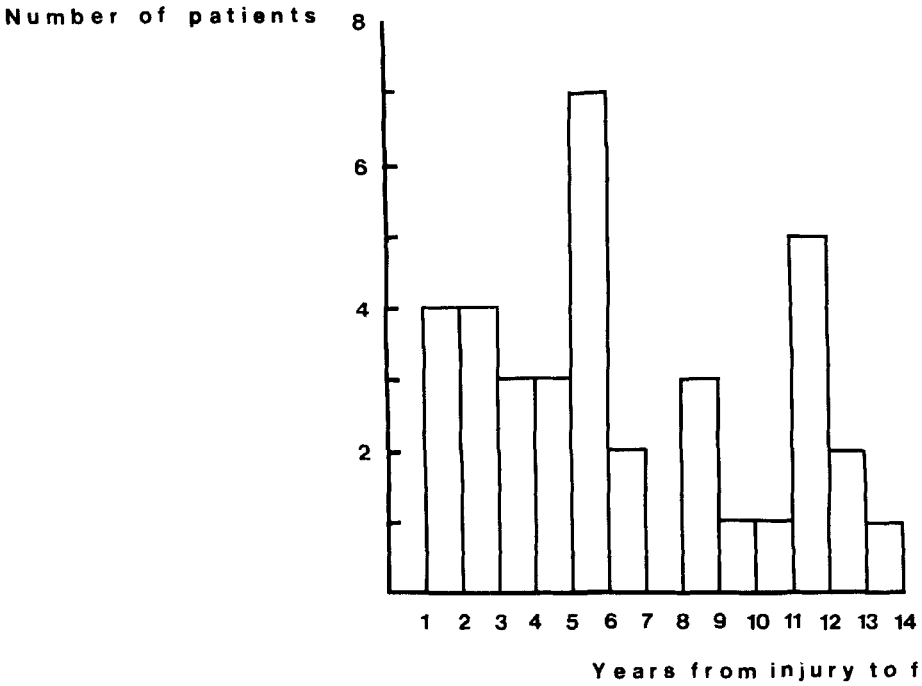


Figure 5. Period of observation at follow-up in 36 patients with fracture of the neck of the talus.

A. Normal appearance.
B. Osteophytes.
C. Reduced joint space including osteophytes and sclerosis. In this group the type of cases included were those where the joint was disorganized by the fracture, but after healing the joint space remained normal (Figures 6 a and b).
D. Anchylosis.

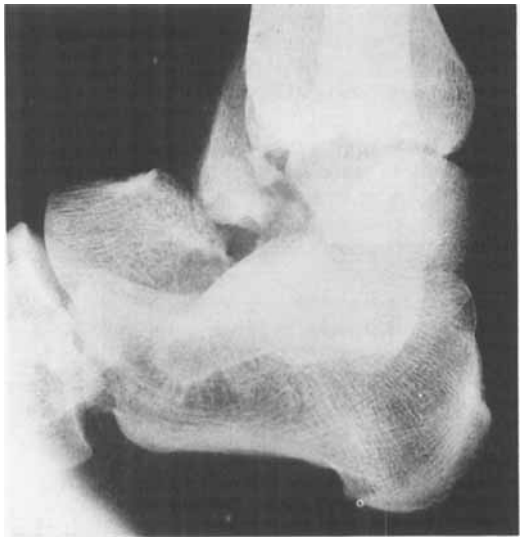


Figure 6 a. Fifty-year-old man with Group III fracture of the neck of the talus treated with closed reduction and immobilization.

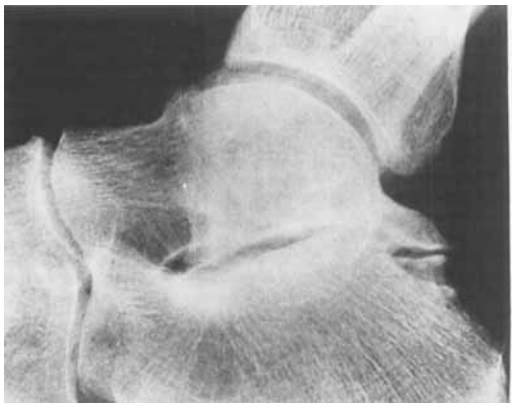


Figure 6 b. Same as in Figure 6 a. At follow-up 13 years and 4 months after injury there is reduction of the posterior subtalar joint space and osteophyte formation.

Table 6. Complaints at follow-up of 36 patients in relation to the patient's general opinion of the function of the foot.

	Classification						Total	
	I		II		III			
Symptoms	Satisfied 4	Unsatisfied 4	Satisfied 8	Unsatisfied 11	Satisfied 5	Unsatisfied 4	Satisfied 17	Unsatisfied 19
Pain at rest	–	–	–	7	–	2	–	9
Pain when walking less than 2 kilometres	–	–	–	6	–	1	–	7
Pain when walking more than 2 kilometres	–	1	–	8	1	2	2	11
Not able to run normally	–	4	1	11	1	4	2	19
Pain when walking on uneven surface	–	4	5	11	2	4	7	19
Limping	–	–	1	5	–	3	1	8
Not able to do ordinary exercise	–	4	1	9	1	3	2	16
Not able to do athletics	2	4	5	11	3	4	10	19
Stiffness	–	3	1	9	1	3	2	15
Tiredness	–	–	–	4	–	2	–	6
Swelling	1	1	–	7	2	2	3	10

RESULTS AT FOLLOW-UP

Symptoms experienced by patients in relation to subjective opinion of function

A relationship was established between the symptoms the patients experienced at follow-up and their subjective opinion of the foot function (Table 6). It is evident from this table that most patients complained of symptoms which to some degree hampered their daily activities.

Of the 36 patients followed up three had no work, two of them being retired and one a student. Of the remaining 33 patients 26 went back to their original work after termination of the compensation period. Quite a number (15) had problems with their foot at work but not to such a degree that it was incapacitating. Four had sedentary work and had no trouble except that they experienced discomfort from their foot during free-time activities.

Seven patients had to change occupation mainly because of pain in the fractured foot.

Of the 36 patients, five needed special equipment such as Lange's foot support and heel-increases.

Objective clinical examination

Limping was found in nine patients.

The bimalleolar circumference compared with the healthy side was increased by 1–3 cm in ten patients and, of these, five belonged to Group III.

The circumference of the lower leg was decreased on the injured side by 2–3 cm in seven patients. Of these, four belonged to Group III.

No atrophy of the skin was noted. One patient (Group II) had a slight varus and excavatus deformity of the fractured foot. One patient (Group III) had a rigid equinus foot (10°). In the remaining patients the foot had a normal appearance.

The range of motion is presented in Table 7.

Table 7. Decrease in range of motion after fracture of the neck of the talus as a percentage of the range measured on the healthy side.

Foot motion	Classification (Hawkins) I	II	III
Dorsal flexion	17	45	31
Plantar flexion	2	10	12
Pronation/supination	12	34	33

Only one patient experienced pain when mobility was tested and this occurred in supination, which was restricted. Unloaded motion of all types was free of pain in the remaining patients.

No crepitations were felt and no instability could be registered. The investigator's assessment is shown in Tables 8 and 9.

Table 8. Investigator's assessment of range of motion at follow-up of 36 patients with fracture of the neck of the talus.

	Classification (Hawkins) I	II	III	Total
Excellent	4	1	1	6
Good	3	6	5	14
Fair	1	10	2	13
Poor		2	1	3
Total	8	19	9	36

Excellent = Normal range of foot motion compared with healthy side.
Good = 0–25 per cent restricted range of foot motion compared with healthy side.
Fair = 26–50 per cent restricted range of foot motion compared with healthy side.
Poor = > 50 per cent restricted range of foot motion compared with healthy side.

Radiologic assessment

This has been centred on evaluation of delayed union, avascular necrosis, degenerative changes, subchondral atrophy and damage to the anterior margin of the tibia.

Delayed union. Delayed union in this material was diagnosed when no healing was radiographically evident within 6 months. There was one delayed union in Group I, four in Group II and one in Group III. All these had united at the time of follow-up. Clinically these patients were free from symptoms excepting one of those in Group II who had developed avascular necrosis (Figure 7).

Avascular necrosis. This developed in six patients, four women and two men. Three were in Group II, three in Group III. Their treatment included early mobilization and weight-bearing.

Degenerative changes. The diagnosis of degenerative changes or osteoarthrosis was based on radiographic criteria of decreased joint space, sclerosis of juxta-articular bone and osteophytes.

The number of patients with degenerative changes in relation to the classification of their injury was as follows:

Classification	I	II	III	Total
Normal appearance	1			1
Osteophytes	5	8	7	20
Reduced joint space including osteophytes and sclerosis	2	10	2	14
Anchylosis		1		1

Subchondral atrophy. During the investigation it became evident that a certain radiologic sign might have some importance in the prognostic estimation of the development of avascular necrosis. Subchondral atrophy was the term used for the demonstration on X-ray films of a thin subchondral line with decreased bone density (Figure 8). This appeared after 6–8 weeks and could either be total or partial. In 18 cases of Group II and III fracture this line of subchondral atrophy was total and in 17 no avascular necrosis developed.

Table 9. Investigator's assessment of clinical results at follow-up of 36 patients with fracture of the neck of the talus.

	Classification (Hawkins) I	II	III	Total
Excellent	4	1	1	6
Good	2	5	4	11
Fair	2	6	2	10
Poor		7	2	9
Total	8	19	9	36

Excellent = Normal range of foot motion compared with healthy side. No pain at rest and none or only minor subjective symptoms. 0–2 symptoms listed in Table 7.

Good = 0–25 per cent restricted range of foot motion compared with healthy side. No pain at rest. 3–5 symptoms listed in Table 7.

Fair = 26–50 per cent restricted range of foot motion compared with healthy side. 6–8 symptoms listed in Table 7.

Poor = > 50 per cent restricted range of foot motion compared with healthy side. 9–11 symptoms listed in Table 7.

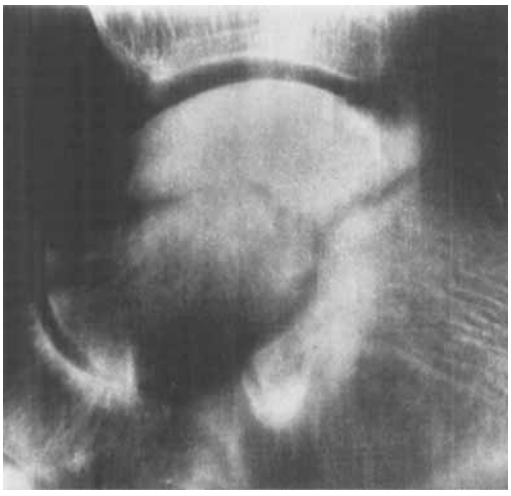
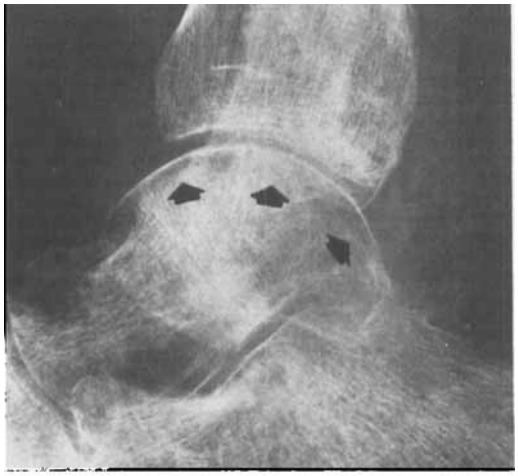
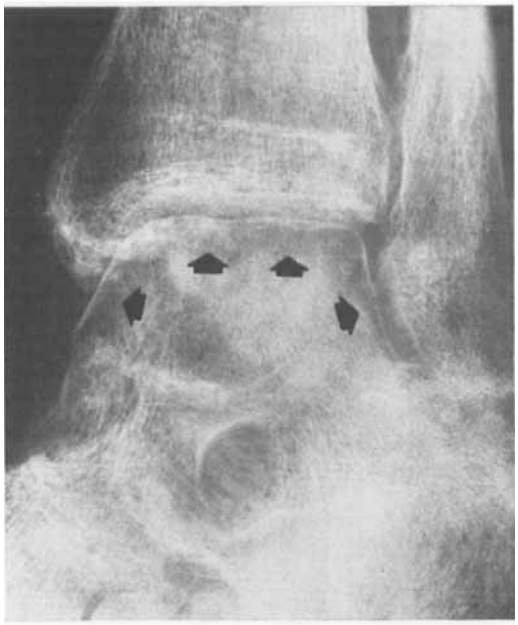


Figure 7. Fifty-six-year-old woman with Group II fracture treated with non-weight-bearing for 6 weeks. Tomogram (in lateral projection) shows non-union 9 months after injury and sclerosis of the talar body.

Damage of the anterior margin of the tibia. Special attention was paid to possible damage to the anterior margin of the distal tibia. Except in one case no skeletal damage was observed at the an-



a.



b.

Figure 8 a, b. Lateral and AP views of Group II fracture of left talus 8 weeks after injury with subchondral atrophy (arrows). This atrophy cannot be seen radiologically through plaster.

terior tibial margin. This gives support to the mechanism of injury of talar neck fractures suggested by Peterson et al. (1976).

DISCUSSION

Fractures of the neck of the talus without displacement have a good prognosis but the occasional complication with avascular necrosis cannot be overlooked (Hawkins 1970, Kenwright & Taylor 1970, Brinkmann et al. 1973). Avascular necrosis is above all a radiologic diagnosis and need not yield any clinical symptoms. In this material there was no evidence of avascular necrosis in the Group I fractures and the clinical results were excellent or good in six out of eight cases. It appeared essential to immobilize the foot in plaster but weight-bearing seemed to have no adverse effects, provided that it was postponed until 1 month after the injury. This period of non-weight-bearing seems to follow naturally after the injury because of the discomfort caused by weight-bearing during the first month.

In previous studies the importance of a good reduction, either closed or open, of displaced fractures has been emphasized (Miller & Baker 1939, Boyd & Knight 1942, McKeever 1963, Coltart 1952, Hawkins 1970). In this material it was obvious that an exact reduction was essential for a good result (Figure 9). Whether the reduction was closed or open did not appear to have any clinical significance, but of course the choice should be made with respect to the possibility of achieving an exact reduction and maintaining this.

Avascular necrosis occurred in one patient of those treated with closed reduction (11).

One patient with avascular necrosis was treated only with non-weight-bearing for 6 weeks and the result was poor.

In this investigation avascular necrosis developed less frequently in displaced fractures which were reduced by closed means, compared with those which required open reduction. However, if open methods were chosen it seemed that avascular necrosis developed less frequently in those fractures which were fixed internally.

Out of 36 fractures, 28 were displaced. Of these, 19 belonged to Group II and three of these developed avascular necrosis. The remaining nine displaced fractures belonged to Group III and of these, three developed avascular necrosis.

The reason for avascular necrosis is obscure. It has been said that at the moment of fracture the rupture of the arteria canalis tarsi and arteria sinus tarsi enhances the risk of avascular necrosis. Support for this belief has been advanced by Marek & Schein (1945) who recorded a rate of 8 per cent avascular necrosis in triple arthrodesis.

In a study of the arterial supply of the talus (Peterson et al. 1974) it was possible to demonstrate that the talus is located in the centre of a vascular network, and is mainly supplied by the arteria canalis tarsi and the anastomosing arteria sinus tarsi, by the rami deltoidei from the arteria canalis tarsi, and by branches from the arteria dorsalis pedis entering the neck of the talus; furthermore, the talus is supplied by small arteries in the capsules and ligaments which connect the talus with the surrounding bones. The involvement of these vessels in the fracture mechanism of the neck of the talus could be demonstrated experimentally (Peterson & Goldie 1975). It was shown that in fractures without displacement the ascending branches from the arteria canalis tarsi were generally ruptured, as well as the descending branches from the arteria dorsalis pedis in the fracture area. With displacement of the body of the talus from the subtalar joint the arteria canalis tarsi generally ruptured, which is in accordance with

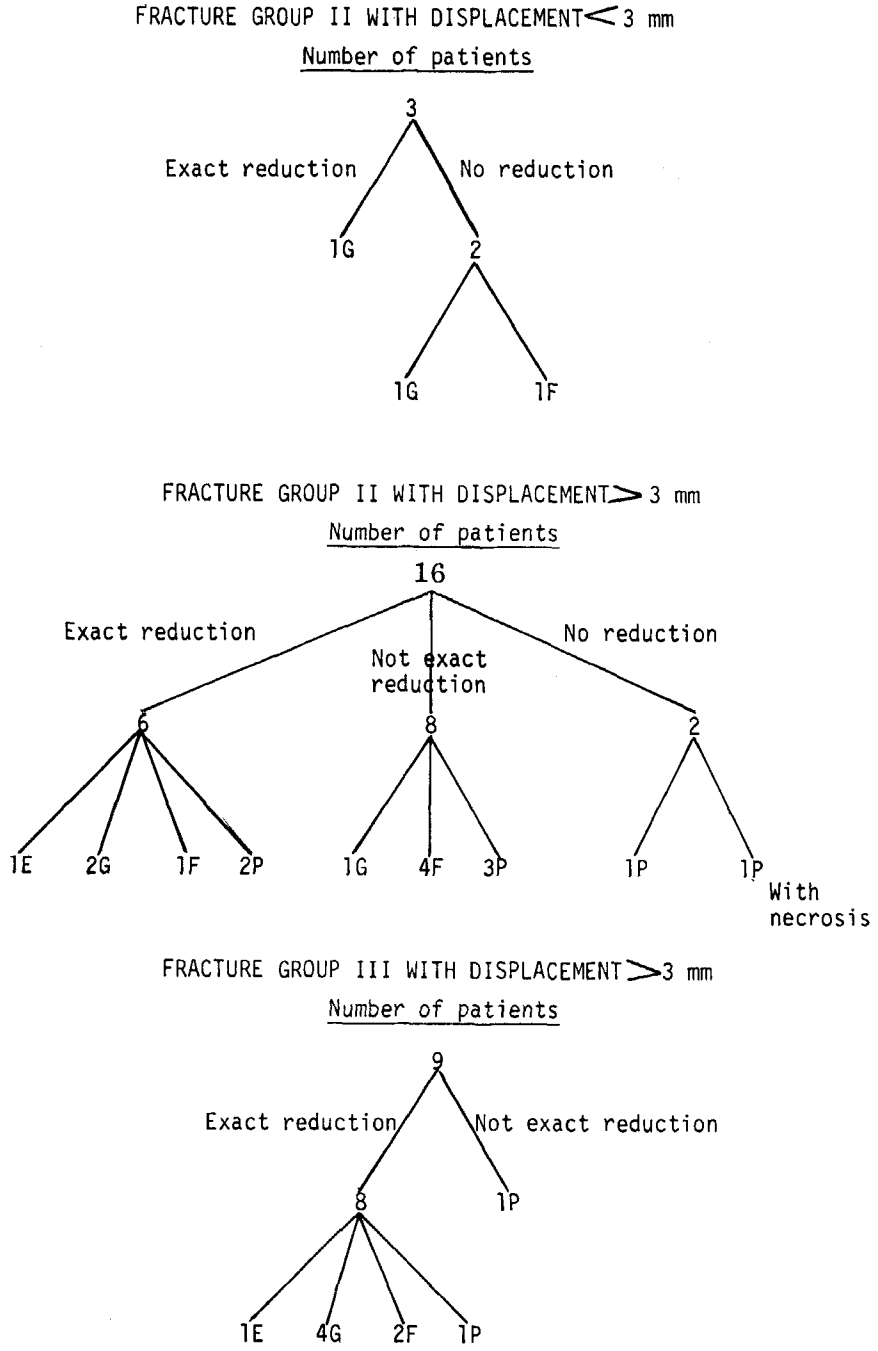


Figure 9. Relation between the degree of reduction of Group II and III fractures and the results at follow-up. E = Excellent, G = Good, F = Fair, P = Poor.

the hypothesis previously discussed by Hawkins (1970).

The clinical implication might be that the talar body can survive on the small but numerous vessels available provided that a prompt, exact and stable reduction can be performed and maintained.

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