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FRACTURE OF THE TALUS

A Study of its Genesis and Morphology Based Upon Cases with Associated Ankle Fracture

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From the literature it seems evident that to a great extent fracture of the talus has been looked upon as an isolated phenomenon rather than as a link in a more comprehensive injury involving also the neighbouring structures, in particular the ankle joint, subtalar joint, and appurtenant ligaments.

However, the talus is well-protected from direct outer forces, and the traumatizing forces are transmitted mainly *via* the adjacent structures. There is reason to assume, therefore, that injury of the talus is often just one link in a more comprehensive injury. As in the case of ankle fractures, increased knowledge about the damage to ligaments and joints associated with talar fracture will no doubt create improved possibilities of rational treatment.

The present study is based on the fact that forces which act upon the talus and produce fracture of this bone affect also the ankle joint which occasionally is fractured at the same time. As far as the ankle fracture is concerned, we already have an essentially sufficient and genetically well-founded classification system (Lauge Hansen 1942, Bæk Kristensen 1949, Dinstl & Spängler 1963, Solonen & Lauttamus 1965). In cases of simultaneous ankle and talus fracture, therefore, the pathological movement of the foot at the moment of the accident is known and can be related to the morphology of the talus fracture.

In the present investigation we have considered the injury of the talus as an integral part of a more comprehensive regional injury. On this basis we succeeded in elucidating some hitherto unknown factors in its genesis.

MATERIAL

The material is partly from the Directorate of Employment Accident Insurance and partly from Dept. U of Orthopaedic Surgery, Rigshospitalet, Copenhagen. The case records including the X-ray reports, representing this material, were perused by the authors.

During the period 1960–1966 a total of 1,806 ankle fractures were reported to the Directorate of Employment Accident Insurance. Among these cases 20 (1 per cent) had simultaneously sustained talar fractures.

This material is representative of the adult population of working age except that it shows a marked male preponderance, since normally housewives are not covered by this insurance.

At Dept. U of Orthopaedic Surgery, Rigshospitalet, 650 cases of ankle fractures were treated during the period 1964–1972. Six (1 per cent) were associated with simultaneously sustained talar fractures.

The material from Rigshospitalet is not entirely representative, as the Department admits a number of cases, as a rule complicated ones, referred from other hospitals. However, the two materials do not exhibit any difference with respect to the simultaneous occurrence of talar and ankle fractures, and they will be considered together in the following report.

Cases in which the injury of the talus was merely a shell-shaped avulsion fracture at the insertions of ligaments or capsule were not included in the present material, seeing that they have nothing in common with other talar fractures as regards either treatment or prognosis.

A total of 26 patients had fracture of the talus and ankle of the same limb. Twenty-five of these ankle fractures could be classified according to a genetic system, whereas one was atypical. This last-mentioned ankle fracture was due to a severe, direct trauma and will not be included in the account below.

Of the remaining 25 patients 21 were males and 4 females. At the time of the accident they ranged in age from 19 to 63 years, average 41 years.

In Table 1 the 25 cases are grouped by type of ankle fracture and nature of trauma. Most of the fractures were due to falls or car accidents, but jamming of the foot under a heavy weight was another common cause.

Table 1. Relationship between type of ankle fracture and genesis of talar trauma.

Type of ankle fracture	Fall 1–8 m	Road accident	Heavy weight over foot	Twisting	Total
Supination	7	5	2	1	15
Pronation	2	1	2	0	5
Supination-external rotation	1	1	1	0	3
Pronation-external rotation	1	1	0	0	2
Total	11	8	5	1	25

In this respect the material accords with other materials of talar fractures (Pennal 1963, Bircher 1965), whereas it differs completely from other materials of ankle fractures (Klossner 1962, Solonen & Lauttamus 1968).

RESULTS

Table 2 gives the occurrence of talar injury in the various types of ankle fracture. It will be seen that supination trauma, in particular, seems to have entailed injury of the talus, the frequency of ankle fractures of the supination type being far higher than in the material as a whole ($P < 0.001$). Pronation was next in order of frequency in relation to talus injury, whereas external rotation trauma on a supinated or pronated foot was relatively uncommon ($P < 0.01$).

Table 2. Relationship between type of ankle fracture and occurrence of talar fracture and/or subtalar dislocation.

Type of ankle fracture	Number of ankle fractures*	Occurrence of talar fracture and/or subtalar dislocation
Supination	295	15 (5.1 %)
Pronation	344	5 (1.5 %)
Supination-external rotation	1326	3 (0.2 %)
Pronation-external rotation	393	2 (0.5 %)
Irregular	98	1 (1.0 %)
Total	2456	26 (1.1 %)

* The 2456 ankle fractures typed on the basis of the percentage distribution in the materials published by Lauge Hansen (1942), Bæk Kristensen (1949) and Solonen & Lauttamus (1968): supination 12 %, pronation 14 %, supination-external rotation 54 %, pronation-external rotation 16 %, and irregular 4 %.

In Table 3 the site of the talar injury is compared to the type of ankle fracture. In this respect it is remarkable that fractures of the neck were relatively common, since generally these fractures are said to result from dorsiflexion trauma.

If the number of fractures affecting the neck of the talus (Table 3) are related to the number of ankle fractures (Table 2), the following percentage may be seen in the various genetic types: supination: 2.7, pronation: 0.9, supination-external rotation: 0.2, pronation-external rotation: 0. Thus, the occurrence of neck fractures following supination

trauma was significantly higher than in the material as a whole ($P < 0.001$).

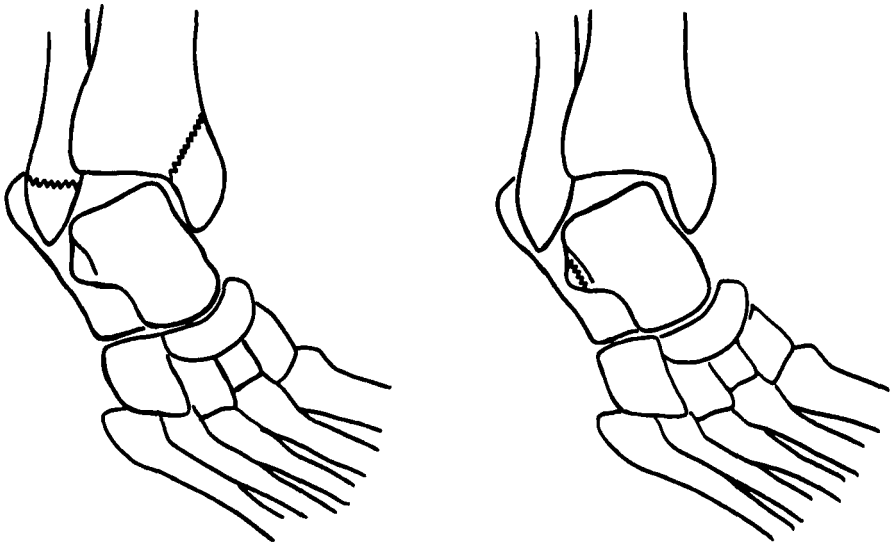
Table 3. Relationship between type of ankle fractures and site of talar injury.

Type of ankle fracture	Fracture of neck	Fracture of trochlea		Subtalar dislocation	Total
		medial	lateral		
Supination	8	6	0	1	15
Pronation	3	0	2	0	5
Supination-external rotation	2	0	0	1	3
Pronation-external rotation	0	0	2	0	2
Total	13	6	4	2	25

Only ***supination injury*** of the talus occurred in numbers which permitted further analysis of the group.

Figure 1 presents a survey of the supination injuries which occurred in the present 15 cases.

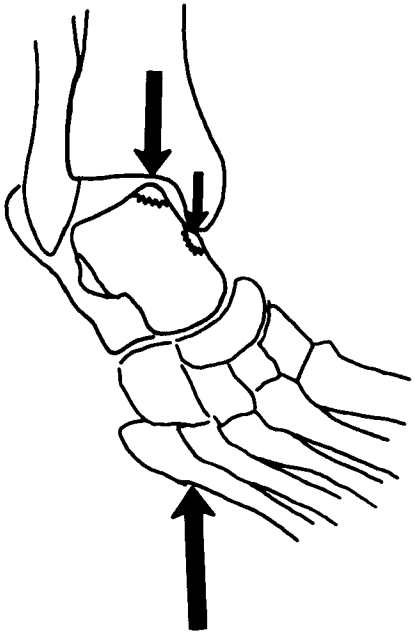
Figure 1 A shows an ankle fracture of the supination type. The



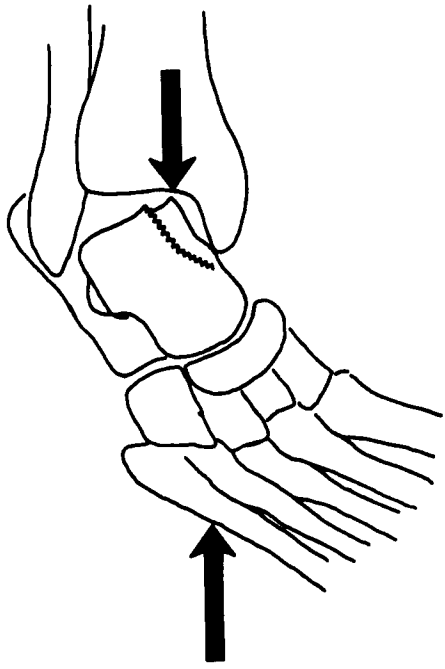
A. Ankle fracture of the supination type.

B. Avulsion fracture of the insertion of the talofibular ligaments.

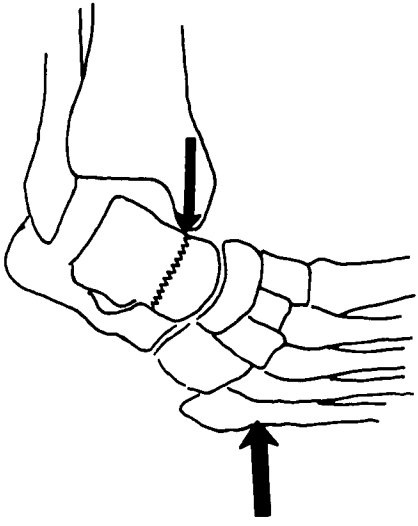
Figure 1. Site of talar injury caused by supination trauma in the present 15 cases.



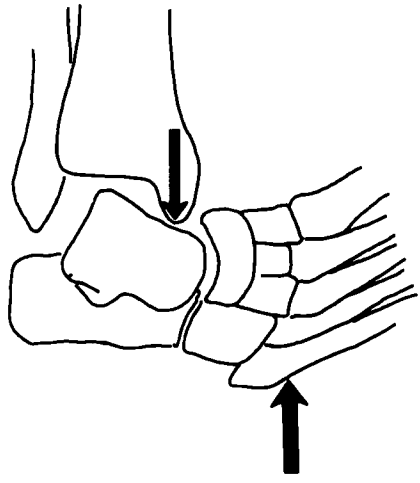
C. Compression fracture on the medial surface of the trochlea and/or at its upper medial margin.



D. Anteposterior fracture of the trochlea.



E. Fracture of the neck.



F. Subtalar dislocation.

Figure 1.

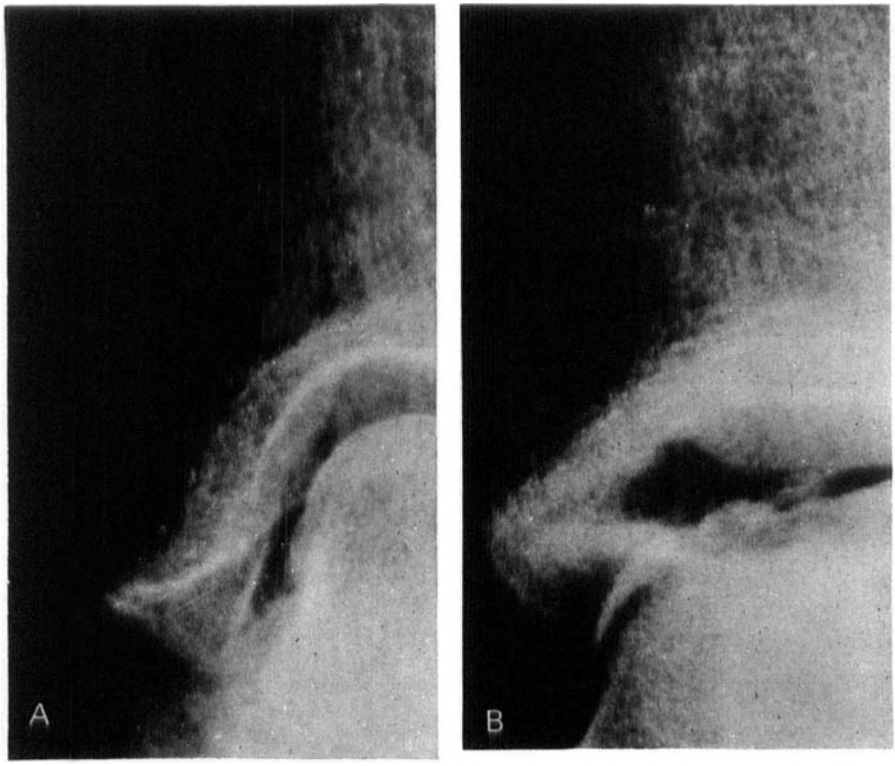


Figure 2. Compression fracture of the medial surface of the trochlea (A) and its upper medial margin (B). In both instances associated ankle fracture of the supination type, stage 1.

initial injury (stage 1) is an avulsion fracture of the lateral malleolus (Figures 3 and 7) or tearing of the lateral collateral ligament of the ankle or an avulsion fracture at its insertion on the talus and calcaneus (Figure 5). Then follows a fairly sagittal fracture up through the base of the medial malleolus (stage 2) (Figures 4 and 6).

Out of the 15 supination injuries 10 were stage 1, including 5 fractures of the neck, 4 of the trochlea, and one case of subtalar dislocation. The remaining 5 cases were stage 2, including 3 fractures of the neck and 2 of the trochlea.

Avulsion from the talus at the insertion of the talofibular ligaments (Figures 1 B and 5) had occurred in 2 cases, one of which co-existed with fracture of the neck, the other one with fracture of the trochlea. Compression fracture on the medial surface of the trochlea on a level with the tip of the medial malleolus was found in one case, compres-

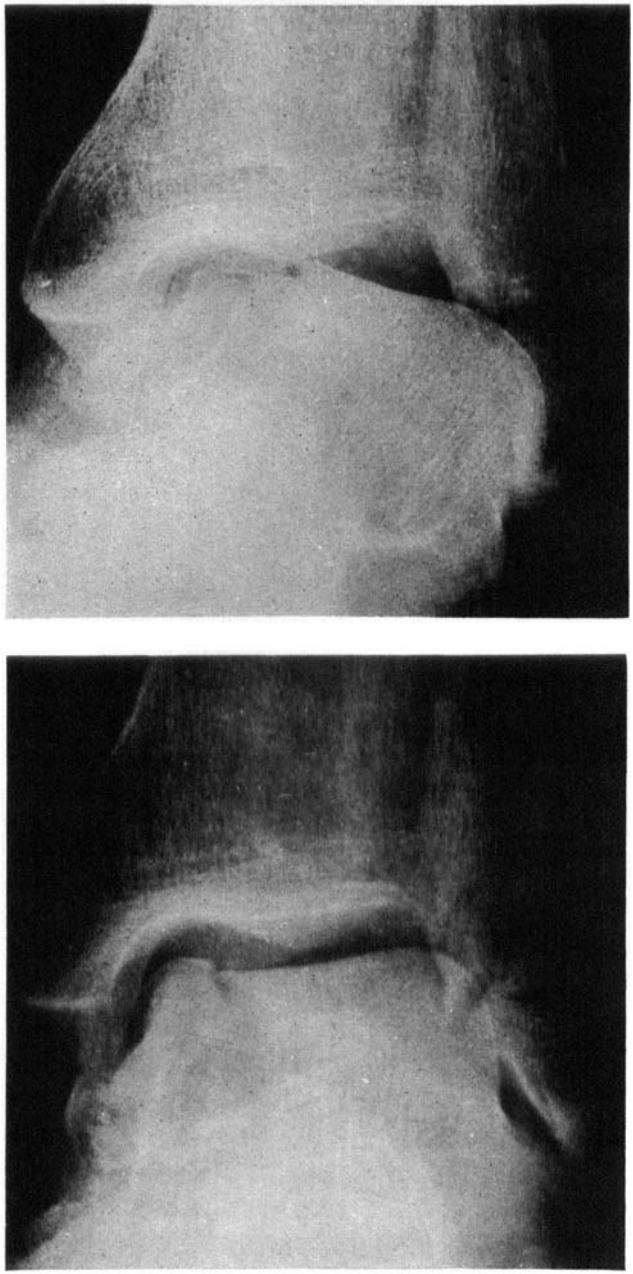


Figure 3. Anteroposterior shearing fracture of the trochlea before and after reduction. Associated ankle fracture of the supination type, stage 1.

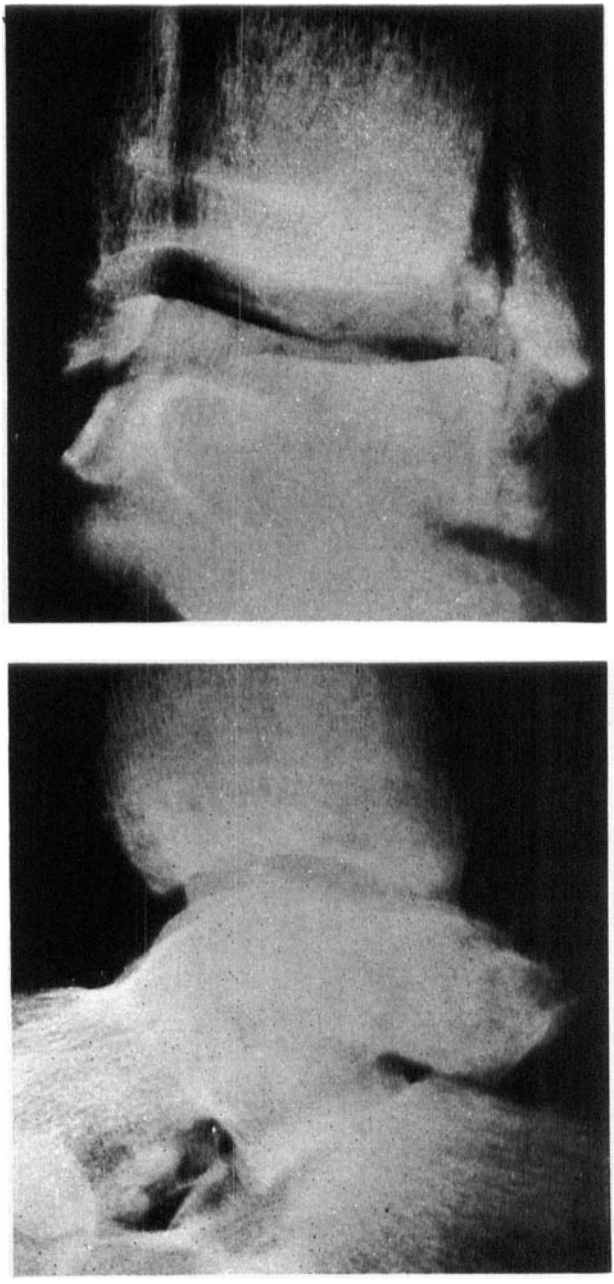


Figure 4. More oblique shearing fracture of the trochlea, involving the subtalar joint with backward displacement of the trochlear fragment. Associated ankle fracture of the supination type, stage 2.

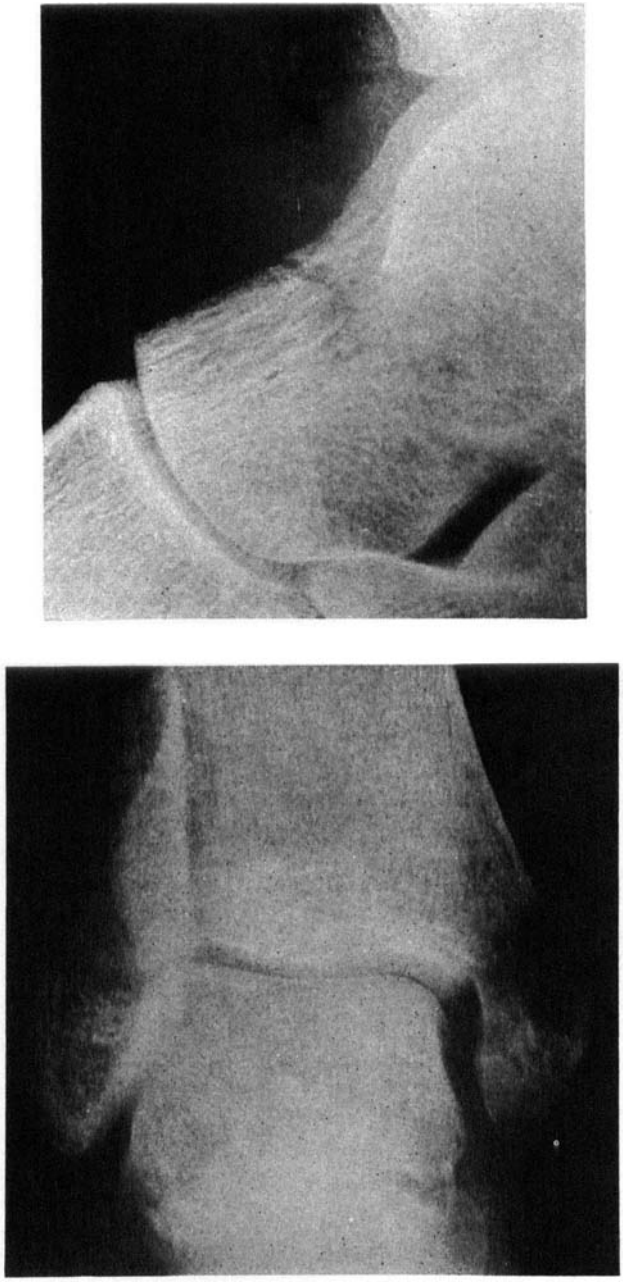


Figure 5. Fracture of the talar neck. Associated ankle fracture of the supination type, stage 2, with avulsion fracture at the insertion of the talofibular ligaments.

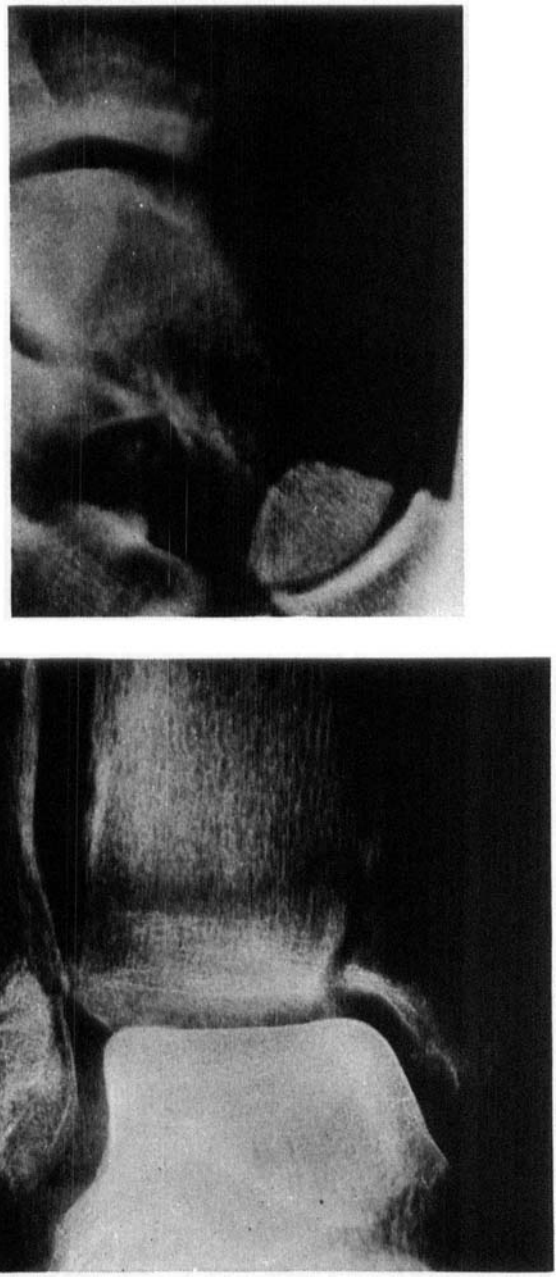


Figure 6. Fracture of the talar neck. Associated ankle fracture of the supination type, stage 2.

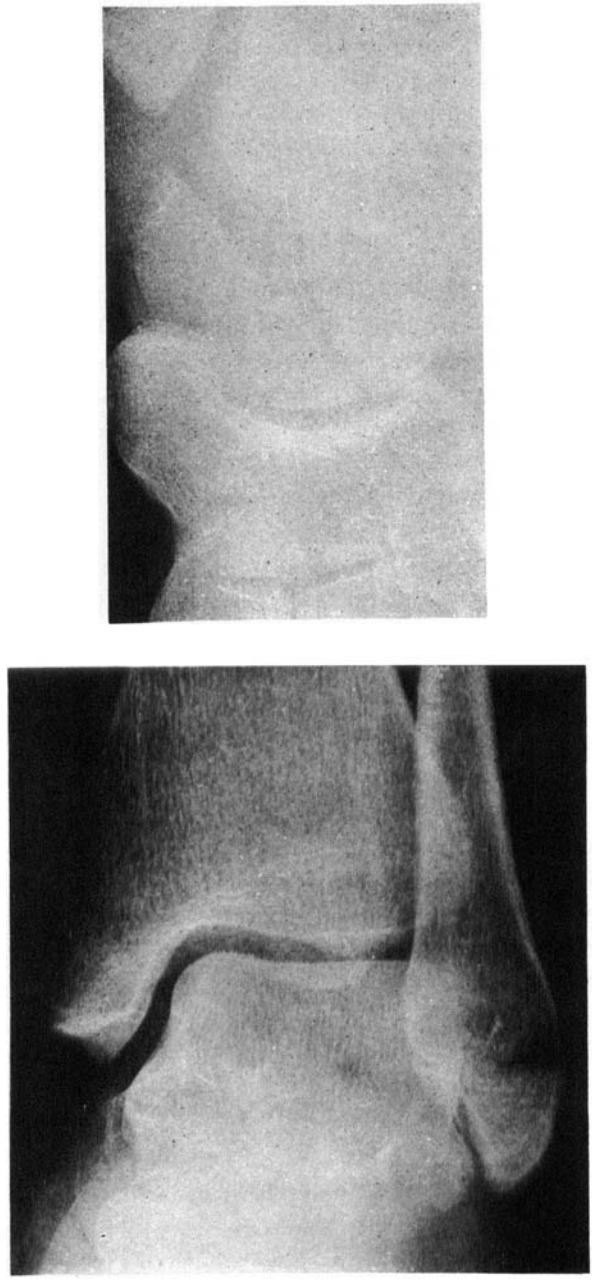


Figure 7. Fracture of the talar neck, coursing from the area at the tip of the medial malleolus to the lateral part of the talonavicular joint. Associated ankle fracture of the supination type, stage 1.

sion fracture at the upper medial margin of the trochlea in one (Figures 1 C and 2). Anteroposterior shearing fracture of the trochlea occurred in 4 cases (Figures 1 D, 3, and 4). In 8 cases there was a fracture of the neck (Figures 1 E, 5, 6, and 7). Lastly, there was one case of subtular dislocation (Figure 1 F).

DISCUSSION

Experimentally an ankle fracture may be induced by forced dorsiflexion of the pronated foot (Lauge Hansen 1942), but in clinical materials a dorsiflexion type of fracture does not seem to occur (Dinstl & Spängler 1963, Solonen & Lauttamus 1965, 1968). A possible dorsiflexion trauma of the talus, therefore, cannot be detected on the basis of the ankle trauma. Consequently, an important field of talar traumatology cannot be elucidated by the present study.

Fractures of the neck of the talus are currently believed to be due to dorsiflexion (Kleiger 1948, Watson Jones 1962, Bircher 1965, Jackson & Dickson 1965), although a few cases are on record in which the genesis appears to have been forced plantar flexion (Pennal 1963).

In the present material, however, the fractures of the neck of the talus were particularly common in relation to supination injury of the foot, but were seen also in pronation and supination-external rotation trauma.

In some cases these fractures of the talar neck may of course be imagined to be due to simultaneous forced dorsiflexion of the foot. But if dorsiflexion alone was the genetic mechanism of fracture of the neck, one would expect an equal distribution of the fractures in conformity with the number of ankle fractures (Table 2). However, the fractures of the neck were of an entirely different distribution (Table 3), and this difference cannot be assumed to be due to chance ($P < 0.001$). Consequently, the theory of dorsiflexion as the sole cause of neck fracture has to be rejected.

Instead, there are two possibilities: Either the named rotating movements of the foot, in particular supination, may *per se* have caused the talar fracture, or else the fracture has been induced by a simultaneous dorsiflexion trauma which in that case must be particularly apt to occur in supination, more rare in pronation or supination-external rotation.

It may be concluded, therefore, that the position of the foot at the moment of the accident was of decisive importance to the frequency

at which fractures of the talar neck occurred. Supination, in particular, predisposed to this fracture. The quantitative role of supination trauma in the genesis of fracture affecting the talar neck cannot be deduced from the present study.

As regards *trochlear fractures,* it was found in the present material that a medial site (Figures 1 C and D) was typical of the supination trauma, whereas a lateral site was typical of pronation or pronation-external rotation trauma (Table 3).

These findings are in conformity with the current views on the genesis of trochlear injuries (Kleiger 1963), but at variance with a few other studies (Cameron 1956, Berndt & Harty 1959, Pennal 1963).

SUMMARY AND CONCLUSION

In a material of 2,456 ankle fractures there were 25 cases of associated ankle fracture and talar fracture or subtalar dislocation. On the basis of a genetic classification of the ankle fracture, it could be concluded that the position of the foot at the moment of accident was of decisive importance to the frequency at which talar fractures occurred, supination in particular predisposing to fracture of the neck as well as trochlea of the talus.

The talar injury which most often occurred in supination, apart from fracture of the neck, was compression fracture or shearing fracture medially in the trochlea.

The injury which occurred in pronation was fracture of the talar neck or a compression fracture laterally in the trochlea.

REFERENCES

Berndt, A. L. & Harty, M. (1959) Transchondral fractures (osteochondritis dissecans) of the talus. *J. Bone Jt Surg.* **41**-A, 988–1020.

Bircher, J. (1965) Frakturen und Luxationen des Talus. *Helv. chir. Acta.* **32**, 289–298.

Cameron, B. M. (1956) Osteochondritis dissecans of the ankle joint. *J. Bone Jt Surg.* **38**-A, 857–861.

Dinstl, K. & Spängler, H. (1963) Über Luxationsfrakturen im Bereich des oberen Sprunggelenks. *Arch. orthop. Unfall-Chir.* **55**, 317–328.

Hansen, N. L. (1942) *Ankelbrud, genetisk diagnose og reposition.* Diss. Munksgaard, Copenhagen.

Jackson, W. S. T. & Dickson, D. D. (1965) Fractures and dislocations. In: Du Vries, H. L. *Surgery of the foot.* C. V. Mosby, Saint Louis.

Jones, Watson (1962) *Fractures and joint injuries.* Livingstone, London.

Kleiger, B. (1948) Fractures of the talus. *J. Bone Jt Surg.* **30**-A, 735–744.

Kleiger, B. (1963) The mechanism and the roentgenographic evaluation of fracture of the tarsal bones. *Clin. Orthop.* **30**, 10–19.

Klossner, O. (1962) Late results of operative and non-operative treatment of severe ankle fractures. *Acta chir. scand.*, Suppl. 293.

Kristensen, B. (1949) Treatment of malleolar fractures according to Lauge Hansens method. Preliminary results. *Acta chir. scand.* **97**, 362–379.

Pennal, G. F. (1963) Fractures of the talus. *Clin. Orthop.* **30**, 53–63.

Solonen, K. A. & Lauttamus, L. (1965) Treatment of malleolar fractures. *Acta orthop. scand.* **36**, 321–336.

Solonen, K. A. & Lauttamus, L. (1968) Operative treatment of ankle fractures. *Acta orthop. scand.* **39**, 223–237.

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