

Department of Orthopaedic Surgery U, University Hospital, Copenhagen, The Directorate of Employment Injuries Insurance, Copenhagen, and Surgical Department D, Glostrup Hospital, Copenhagen.

PSEUDARTHROSIS OF THE LATERAL MALLEOLUS

OTTO SNEPPEN

Accepted 22. iv. 71

Although the incidence and prognostic significance of medial malleolar pseudarthrosis has been fairly well elucidated (Sneppen 1969), far less is known about pseudarthrosis of the lateral malleolus. The explanation is no doubt primarily that lateral malleolar pseudarthrosis is relatively uncommon, so that only a few cases are on record.

In 1930 Lützeler published the first case of non-union of lateral malleolar fracture, and Rostock, in 1938, added four on which, however, the follow-up was very brief. Since then, a number of authors (Hallock 1945, van de Voorde et al. 1950, Fackert 1954, Cohen & Foulitz 1960, Jones & Neal 1962, Cave 1965, Pouyanne et al. 1965, Pizio & Mazur 1968) have been able to submit single or a few cases, bringing the total number of published cases up to 35.

Moreover, the great majority have only a very brief follow-up period, so that the diagnosis of pseudarthrosis is based merely upon the absence of bony union a few months after the accident.

A very few authors have published materials which permit an assessment of the incidence at which pseudarthrosis occurs after ankle fractures involving the lateral malleolus. These materials are listed in Table 1 from which it is apparent that pseudarthrosis of the lateral malleolus seems to develop in about one per cent of conservatively treated fractures.

Only a few have studied the prognosis of lateral malleolar pseudarthrosis. Mendelsohn (1958) and Cave (1965) believed that this complication made for a poor prognosis of the ankle fracture, but this assumption was based upon only a few cases. Therefore, the prognostic role of lateral malleolar pseudarthrosis must be said to be unknown in all essentials.

On this background the present study was performed in an effort

Table 1. Incidence of fibrous union in the lateral malleolus.

Author	No. of ankle period fractures	Follow-up	No. of lat mall. fractures with fibrous union	Comments
Van de Voorde (1950)	293	?	1 (0.3 %)	
Barigazzi (1960)	101	?	1 (1 %)	All the ankle fract. involved the lat. mall.
Banchero & Rettagliata (1960)	131	4-15 mo.	2 (2 %)	
Jones & Neal (1962)	125*	?	1 (1 %)	
Mendelsohn (1965)	194*	5-10 yrs.	2 (1 %)	All the ankle fract. involved the lat. mall.
Solonen & Lauttamus (1965)	116*	2-12 yrs.	1 (1 %)	
Bär (1966)	216	2-11 yrs.	2 (1 %)	
Total	1176		10 (1 %)	

* In these 3 series a number of the ankle fractures had been treated by operation, in the remaining 4 only conservatively.

to elucidate the aetiology, incidence, and prognosis of lateral malleolar pseudarthrosis on the basis of a fairly large material with a relatively long follow-up period.

Definition of Lateral Malleolar Pseudarthrosis

Only a couple of authors have tried to define in some detail what they take to be pseudarthrosis or non-union of a malleolus. Böhler (1957) felt that a case could not be called one of malleolar pseudarthrosis unless a gap of more than 3 mm between the fracture surfaces remained 6 months after the fracture. Mendelsohn (1958) used the concept non-union in connection with malleolar fractures when a fracture line at least 2-3 mm wide and sclerosing of the fracture surfaces were present at least 6 months after the fracture.

Such rigid definitions, however, have proved fairly inapplicable to sizable series.

With Böhler's definition, the claim of a minimum gap of 3 mm excludes cases with a less, but distinctly open fracture gap perhaps after several years' follow-up, and with Mendelsohn's definition many cases with a wide fracture gap cannot be included merely because the fracture surfaces are not sclerosed.

A sufficiently flexible definition can apparently be based only upon the finding of lacking radiographic evidence of union after a suitable follow-up period, whether this period is fixed as 6 months or more.

In the present study the following definition of lateral malleolar pseudarthrosis was used: Absence of bony union at least 9 months after a fracture affecting the area from about 2 cm proximal to the malleolar base to the malleolar apex, presupposing that the malleolar fragment is at least 5 mm in diameter. Oblique fractures extending from the malleolar base more proximally than the named 2 cm are included. On the other hand, minor shell-shaped chips found at times in connection with ligamentous avulsions are excluded.

M A T E R I A L

The basic materials are as follows:

1. All ankle fractures notified to the Directorate of Employment Injuries Insurance in Denmark during the period 1945-1966, excluding cases not recognized as coming within the Employment Injuries Insurance Act.
2. All cases of lateral malleolar pseudarthrosis treated in the Orthopaedic Hospital, Copenhagen, during the Period 1934-1968.
3. All cases of lateral malleolar pseudarthrosis treated in the Department of Orthopaedic Surgery U, of the University Hospital, Copenhagen, during the period 1964-1969.

These materials included a total of 25 patients with pseudarthrosis of the lateral malleolus, 16 derived from the insurance series, 2 from the Orthopaedic Hospital, Copenhagen, and 7 from Department U of the University Hospital, Copenhagen.

Out of these 25 patients 1 underwent talo-crural arthrodesis and was, therefore, not included in the follow-up study. Out of the remaining 24 patients 23 (96 per cent) were examined by the author.

The only patient who was not seen at follow-up had gone to Australia and was contacted by letter. He reported that in spite of fairly heavy, standing work he had only occasional, negligible complaints in the form of slight fatigue in the ankle.

Table 2. Incidence of lateral malleolar pseudarthroses in relation to morphology of ankle fracture. The table lists only the insurance series.

Type of fracture	No. of cases	No. of lateral malleolar pseudarthroses
Fibula	2445	3 (0.1 %)
Fibula + margo posterior tibiae	330	0
Fibula + malleolus medialis	1128	9
Fibula + malleolus medialis + margo posterior tibiae	766	4
Others	91	0
Total	4760	16 (0.3 %)

Of the 23 patients seen at follow-up, 2 were females and 21 males. At follow-up the patients ranged in age from 20 to 68 years, average age 45 years.

The follow-up period from the time of the accident until follow-up ranged from 3 to 23 years, average 9.6 years.

Aetiology and Incidence

Table 2 gives the incidence of lateral malleolar pseudarthroses in relation to the morphology of the fracture. It will be noted that the table comprises exclusively the insurance series which included 4760 ankle fractures involving the fibula. Among these cases pseudarthrosis occurred in 16 (0.3 per cent).

It may be seen from the table that whereas ankle fractures which did not involve the medial malleolus showed an incidence of lateral malleolar pseudarthrosis of 0.1 per cent, ankle fractures involving the medial malleolus showed an incidence of pseudarthrosis of 0.7 per cent. The difference is significant ($p < 1$ per cent).

Thus, the medial stability of the ankle seems to influence the incidence at which pseudarthrosis of the lateral malleolus occurs.

In Table 3 the 23 cases of lateral malleolar pseudarthrosis are distributed by type and stage of fracture according to the genelic classification of fractures introduced by Lauge Hansen (1942). The table also gives the corresponding distribution in a control material. Clearly, the distribution in the pseudarthrosis material differs mark-

Table 3. Distribution of the lateral malleolar pseudarthroses of the follow-up material by type and stage of fracture compared with the distribution in a control material of ankle fractures. The control material is composed of the series reported by: Lauge Hansen (1942), Bæk Kristensen (1953), Solonen & Lautlamus (1968).

Type of fracture	Stage	Lateral pseudarthroses	Control material
SA	I	9 (39 %)	62 (6 %)
	II	7 (30 %)	85 (9 %)
SE	II	1 (4 %)	201 (21 %)
	III	0	86 (9 %)
	IV	5 (22 %)	432 (45 %)
PA	III	1 (4 %)	102 (11 %)
Total		23 (100 %)	968 (100 %)

edly from that in the control material. For instance, 69 per cent of the lateral malleolar pseudarthrosis developed in cases with fractures of the SA type (supination fractures), whereas only 15 per cent of the control cases had developed from fractures of this type. This difference in the incidence is highly significant ($p < 0.1$ per cent).

In other words, especially the transverse avulsion fractures, i.e. the



Figure 1. Lateral pseudarthrosis commonly follows upon fractures of the supination type. In this case 11-year follow-up period.

Table 4. Position of talus and position of malleolar fragment in 23 cases of pseudarthrosis of the lateral malleolus. The table lists the follow-up material.

	Malleolar fragment <i>in situ</i>	Malleolar fragment displaced	Total
Talus <i>in situ</i>	12	5	17
Talus varus tilted or medially subluxated	1	3	4
Talus valgus tilted or laterally subluxated	0	2	2
Total	13	10	23

supination fractures, of the lateral malleolus predispose to pseudarthrosis in this site (Figure 1).

The position of the talus and of the lateral malleolar fragment in the cases with pseudarthrosis is illustrated by Table 4. Out of the 25 cases 4 had varus displacement and/or medial subluxation of the talus (Figure 2), whereas only 2 had valgus displacement and/or

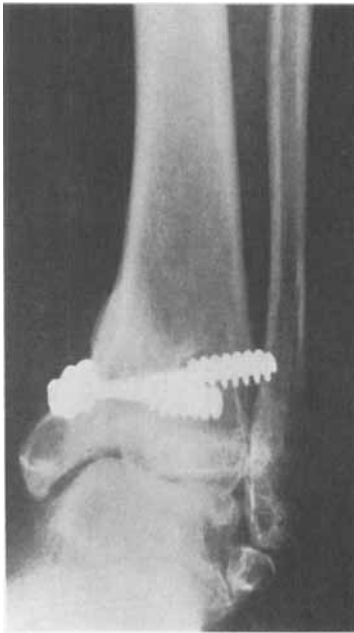


Figure 2. Pseudarthrosis distally in the lateral malleolus after a supination fracture. Marked varus tilting of the talus. 13-month follow-up period.



Figure 3. Spontaneous union of pseudarthrosis proximally in the lateral malleolus. The picture on the left illustrates the status 12 months after the accident, showing perhaps incipient union centrally in the pseudarthrosis. The picture on the right shows the status 18 years after the injury.

lateral subluxation of the talus. Accordingly, there seems to be a certain relationship between varus displacement and/or medial subluxation of the talus and lateral malleolar pseudarthrosis.

Prognosis

The influence of lateral malleolar pseudarthrosis upon the long-term prognosis may be assessed on the basis of the 23 followed cases having this complication.

At the time of follow-up 11 of the 23 pseudarthroses had undergone bony union, 3 of them after operative treatment of the pseudarthrosis. Twelve were still ununited at the time of follow-up.

Among the 20 cases of lateral malleolar pseudarthrosis not treated by operation, 12 were localized close to the malleolar apex, and among these 12 cases only 3 had undergone spontaneous union. On the other hand, 5 out of 8 cases of a more proximal localization had united (Figure 3).

Table 5. Radiological findings in 23 cases of pseudarthrosis of the lateral malleolus. The table lists only the follow-up material.

Radiological result	No osteo- arthritis	Mild or severe osteoarthritis	Total
Good (no displacement)	10	4	14
Fair (negligible displacement)	3	0	3
Poor (marked displacement)	0	6	6
Total	13	10	23

On the basis of the present definition of lateral malleolar pseudarthrosis, then, this pseudarthrosis showed a marked tendency to spontaneous union. This tendency seems to be particularly marked for pseudarthroses localized proximally in the malleolus.

The X-ray findings in the 23 cases of pseudarthrosis are apparent from Table 5.

The classification of the radiological result shown in this table was based on the following criteria:

A good radiological result means no radiologically demonstrable displacement.

A fair radiological result means a maximum forward or backward displacement of 2 mm of the medial malleolus. Maximum backward displacement of the lateral malleolus 2 mm. Maximum elevation of posterior tibial fragment 2 mm.

A poor radiological result means a displacement more marked than mentioned above.

From the table it is apparent that the *incidence of osteoarthritis* was relatively low in cases with a good or fair radiological result, there being only 4 cases among 17. On the other hand, all 6 patients with a poor radiological result had osteoarthritis of the talo-crural joint. One of these 6 patients also had subtalar osteoarthritis.

Out of the 13 cases without osteoarthritis, 4 showed the pseudarthrosis to be localized at the malleolar base, 9 more distally in the malleolus.

The fairly low incidence of osteoarthritis in cases with a good or fair radiological result indicated that the lateral malleolar pseudarthrosis is not a factor in the development of osteoarthritis in the talo-crural joint. To investigate this aspect in some more detail, the occurrence of osteoarthritis in the united and in the ununited cases of lateral malleolar pseudarthrosis is compared in Table 6. No dif-

Table 6. Incidence of osteoarthritis in 17 cases of lateral malleolar pseudarthrosis with a good or fair radiological result.

Status of pseudarthrosis	No osteoarthritis	Mild osteoarthritis	Severe osteoarthritis	Total
United	6	1	1	8
Ununited	7	1	1	9
Total	13	2	2	17

ference is seen between the two groups, a further indication that lateral malleolar pseudarthrosis plays no role in the development of osteoarthritis (Figure 4).

In 4 cases the *mobility of the malleolar fragment* was studied in anteroposterior X-rays with the foot in maximum supination and in maximum pronation, but only one case gave an impression of mobility (Figure 5). In this case the follow-up period was 13 years, but there were no radiological signs of osteoarthritis.

To investigate further whether lateral malleolar pseudarthrosis might have any influence upon the prognosis of the ankle fracture, the clinical results in united and in ununited cases are compared in Tables 7 and 8. These tables include only cases with a good or fair



Figure 4. Pseudarthrosis of the lateral malleolus. 13-year follow-up period. No osteoarthritis.



Figure 5. Lateral malleolar pseudarthrosis with a mobile malleolar fragment. No osteoarthritis. 13-year follow-up period.

radiological result and without osteoarthritis, as this gives a clearer picture of the symptoms and signs of malleolar pseudarthrosis.

The classification of the clinical result, used in the tables, is based upon the following criteria:

A good subjective result means no complaints or mild complaints upon extra strain.

A fair subjective result means more severe complaints on extra strain or daily mild complaints which, however, do not influence the patient's normal activity.

A poor subjective result means more severe complaints than mentioned above.

A good objective result means essentially normal objective findings.

A fair objective result is taken to mean that at least one of the movements in the ankle or other joints of the foot is restricted to between one-third and one-half and/or about 1 cm muscular wasting of the lower leg or thigh. No deformity of the foot or ankle. Gait normal.

A poor objective result is taken to mean a more restricted mobility or a more pronounced muscular atrophy than mentioned above, or deformity of the foot or ankle or abnormal gait.

It is evident from the tables that in this material there was no demonstrable difference in subjective or objective result between ankle fractures with lateral malleolar pseudarthrosis and corresponding ankle fractures without this complication.

Table 7. Subjective result in cases with united and with ununited pseudarthrosis of the lateral malleolus.

Only cases with a good or fair radiological result and without osteoarthritis are included.

Status of pseudarthrosis	Subjective result			Total
	Good	Fair	Poor	
United	3	2	1	6
Ununited	5	1	1	7
Total	8	3	2	13

Table 8. Objective result in cases with united and with ununited pseudarthrosis of the lateral malleolus.

Only cases with a good or fair radiological result and without osteoarthritis are included.

Status of pseudarthrosis	Objective result			Total
	Good	Fair	Poor	
United	5	0	1	6
Ununited	6	0	1	7
Total	11	0	2	13

There was also no evidence to indicate that lateral malleolar pseudarthrosis gave rise to any characteristic symptoms or signs. For instance, among the cases listed in Tables 7 and 8, there were among 6 united cases 2 with instability or pain when walking on rough ground, 2 with pain localized specially around the lateral malleolus, and 2 with distinct tenderness on the lateral malleolus, whereas among the 7 cases with persisting pseudarthrosis there was only 1 with instability and none with pain or tenderness localized particularly at the lateral malleolus.

DISCUSSION

Mendelsohn (1958) and Cave (1965) claimed that lateral malleolar pseudarthrosis caused a poor prognosis. As an explanation Cave

mentioned the pressure of the talus on the lateral malleolus when the foot is brought into pronation. In this connection, it must be borne in mind that during weight-bearing in the upright position the lateral malleolus carries about one-fifth of the talar pressure (Weber 1966). Therefore, an ununited lateral malleolar fracture was supposed to entail considerable instability of the ankle joint, leading to a poor prognosis.

However, that an intact lateral malleolus need not necessarily be a presupposition for a functioning ankle is shown by a publication by Campbell (1938): A patient who had undergone resection of the distal one-fourth of the fibula including the lateral malleolus 20 years previously had only negligible complaints and no osteoarthritis. Soustelle et al. (1966) reported on a similar case in which a patient had been subjected to resection of the lateral malleolus on a level with the talo-crural joint. Three years later there were no complaints worth mentioning, no instability, and no signs of osteoarthritis.

In accordance with the last-mentioned findings, the present study appears to show that pseudarthrosis of the lateral malleolus does not at long sight exert any influence upon the incidence of osteoarthritis or upon the clinical appearance. In other words, lateral malleolar pseudarthrosis does not influence the long-term prognosis of the ankle fracture.

SUMMARY AND CONCLUSION

On the basis of a review of 4760 consecutive ankle fractures involving the fibula and a follow-up examination of 23 cases of pseudarthrosis of the lateral malleolus, average follow-up period 9.6 years, the following conclusions are drawn:

Re aetiology and incidence

1. The medial stability of the ankle, the medial malleolus, is an important factor in the aetiology of lateral malleolar pseudarthrosis. This is manifest in a considerably higher incidence in ankle fractures involving also the medial malleolus (Table 2).
2. Ankle fractures of the supination type relatively often give rise to pseudarthrosis of the lateral malleolus (Table 3).
3. Varus displacement and medial subluxation of the talus are relatively common among cases of pseudarthrosis of the lateral malleolus and are perhaps factors in its aetiology (Table 4).

Re prognosis

1. Lateral malleolar pseudarthrosis shows a marked tendency to spontaneous union, in particular when localized proximally in the malleolus.
2. Lateral malleolar pseudarthrosis does not predispose to osteoarthritis in the ankle joint (Tables 5 and 6).
3. Lateral malleolar pseudarthrosis does not influence the long-term prognosis of the ankle fracture (Tables 7 and 8).

REFERENCES

- Banchero, A. & Rettagliata, F. (1960) Le pseudartrosi nelle fratture malleolari. *Minerva ortop.* **11**, 610.
- Barigazzi, P. D. & Genta, V. (1960) Considerazioni sul trattamento delle fratture malleolari. *Minerva ortop.* **11**, 639.
- Bär, W. (1960) Über Spätergebnisse konservativ behandelte Luxationsfrakturen im oberen Sprunggelenk. *Beitr. Orthop. Traum.* **13**, 408.
- Böhler, L. (1957) *Die Technik der Knochenbruch Behandlung*, pp. 2074–2077. Maudrich, Wien.
- Campbell, W. G. (1938) The treatment of ankle fractures. *Lancet* **235**, 2, 872.
- Cave, E. F. (1965) Complications of the operative treatment of fractures of the ankle. *Clin. Orthop.* **42**, 13.
- Cedell, C. A. (1967) Supination-outward rotation injuries of the ankle. *Acta orthop. scand.* Suppl. 110.
- Cohen, J. & Foults, W. S. (1960) Failure by corrosion of a Steinmann pin used for intramedullary fixation. *J. Bone Jt Surg.* **42-A**, 1201.
- Fackert, S. (1954) Zur operativen Behandlung von Knöchelbrüchen und Pseudarthrosen. *Arch. orthop. Unfall-Chir.* **46**, 513.
- Hallock, H. (1945) Arthrodesis of the ankle joint for old painful fractures. *J. Bone Jt Surg.* **27-A**, 49.
- Hansen, N. L. (1942) *Ankelbrud.* (Thesis). Munksgaard, Copenhagen.
- Hendelberg, T. (1943) Om brott å bakre tibiakanten vid malleolfracturer jämte bidrag till kännedomen om ligament och kapselskadorna. *Uppsala Läk.-Fören. Förh.* **49**, 164.
- Jones, W. C. & Neal, E. G. (1962) Survey of fractures of medial malleolus. *Sth. med. J. (Bgham, Ala.)* **55**, 1054.
- Kristensen, T. B. *Ankelbrud.* (Thesis). Arnold Busck, Copenhagen.
- Lützel, H. (1930) Die Entstehung der Pseudarthrose nach Bruch des innern Knöchels Deutsch. *Z. Chir.* **226**, 404.
- Mendelsohn, H. A. (1958) Nonunion of malleolar fractures of the ankle. *Clin. Orthop.* **11**, 233.
- Pizio, Z. & Mazur, J. (1968) Staw rzekomy kostki Bocznej Geleni. *Chir. Narzad. Ruchu* **33**, 411.
- Pouyanne, L., Honton, J. L., Gourdon, A., Planés, A. & Clarac, J. P. (1965) Deux observations de pseudarthrose de la malléole externe. *Bordeaux chir.* **3**, 110.

- Rostock, P. (1938) Die Malleolarpseudarthrosen. *Langenbecks Arch. klin. Chir.* **191**, 557.
- Sneppen, O. (1961) Long-term course in 119 cases of pseudarthrosis of the medial malleolus. *Acta orthop. scand.* **40**, 807.
- Solonen, K. A. & Lauttamus, L. (1965) Treatment of malleolar fractures. *Acta orthop. scand.* **36**, 321.
- Solonen, K. A. Lauttamus, L. (1968) Operative treatment of ankle fractures. *Acta orthop. scand.* **39**, 223.
- Soustelle, J., Bertocchi, R. & Chapuis, J. P. (1966) Resultat éloigné d'une résection de la malléole externe. *Lyon Chir.* **62**, 711.
- Täger, K. H. (1960) Die Bolzung der Malleolarfracturen mit dem Cialitspan. *Verh. dtsh. orthop. Ges.* **48. Kongress**, 438.
- Weber, B. G. (1966) *Die Verletzungen des oberen Sprunggelenkes*. Hans Huber, Bern & Stuttgart.
- Voorde, C. Van de, de Wulf, A. & Verecken, E. (1950) Séquelles des traumatismes de cou-de-pied. *Acta orthop. Belg.* **16**, 117.