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TREATMENT OF PSEUDARTHROSIS INVOLVING THE MALLEOLUS

A postoperative follow-up of 34 cases

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Surgical treatment of pseudarthrosis involving the malleolus had apparently not been attempted until late in the 19th century (Hueter 1877, Louart 1896, Nasse & Borchardt 1901) and consequently, such treatment had in principle to be based on the not too encouraging experience hitherto gained in the treatment of pseudarthroses at other sites, especially in the long tubular bones.

Indications for surgical treatment have varied parallel with variations in evaluations concerning the prognostic prospects of malleolar pseudarthrosis. It is in particular the rather common pseudarthrosis of the *medial* malleolus that has been an object of discussion. For instance, several authors held that the prognosis of this type of pseudarthrosis was of severe nature and consequently also that operations should be performed on all cases. Weigl (1949) and Bedogni & Bergami (1962) shared this point of view, whereas Plaue (1967) argued that operation should be performed only in the case of young patients, taking into consideration the involved hazards of arthrosis.

Schmidt (1929), Felsenreich (1937) and Lange (1967) were of the opinion that surgical measures should be reserved for the rather uncommon "mobile pseudarthrosis", although other types of the lesions were to be surgically treated only if symptoms were in evidence or specific conditions applied.

According to Täger (1960), Harvey (1965), Fischetti & Savoini (1965), and Solonen & Luttamus (1968), the factor "mobility" was not an adequate criterion on which to decide whether or not operation was indicated; these authors preferred to operate on all cases

Table 1. Results obtained by surgical treatment of pseudarthrosis involving the medial malleolus.

Author	Pre-operative follow-up	Pseudarthrosis no. of cases	Postoperative osseous union no. of cases	Comments
Weigl (1949)	?	2	2	Postoperative fixation of the foot in adducted position (relief of the deltoid ligament)
Küntschner (1953)	5 months	1	1	
Laurent (1956)	10-20 months	3	3	
Galvante & Salvagini (1960)	2-24 months	5	3	Union is uncertain in the remaining 2 cases
Walter (1964)	5-13 months	3	3	Union not achieved until 4-6 months after operation
Total		14	12	

Surgical method: Excision of fibrous tissue, restoration of fracture surfaces, and fixation of the fragment by bone peg or clamp.

in which complaints were of severe character. Plaue (1967) warned against the use of such an indication, pointing out that fractures might be followed by sequelae other than pseudarthrosis.

The *surgical methods* can be classified into different categories accordingly as bone grafts are applied or the pseudarthrosis is excised.

It appears from Tables 1, 2, and 3 that results to be obtained by the various methods had been encouraging, even in cases in which bone grafts had not been applied and in those in which the pseudarthrosis had not been excised.

It should be noted, however, that patients included in the series cited in the tables had been followed only for short periods of time prior to operation; furthermore, the results obtained in these series are probably optimal results, since authors are not much inclined to submit reports of series in which poor results were obtained. Actually, several authors have mentioned that they abandoned one or the other type of operation because of the poor results obtained.

Table 2. Results obtained by surgical treatment of pseudarthrosis involving the medial malleolus.

Author	Pre-operative follow-up	Pseudarthrosis no. of cases	Postoperative osseous union no. of cases	Comments
Andresen (1938)	?	11	10	Sliding bone graft
Banks (1949)	?	2	2	
Banchero & Rettagliata (1960)	?	2	2	
Täger (1960)	?	28	25	Fixation by heterologous bone peg
Fischetti & Savoini (1965)	ca. 3 months	2	?	Block of spongy tissue from tibia in the defect of the pseudarthrosis. Union not reliable until years later
Plaue (1967)	> 3 months	10	9	In the remaining case, union occurred within 11 months
Total		55	48	

Surgical method: Excision of fibrous tissue, restoration of fracture surfaces, fixation of the malleolar fragment and application of bone grafts (inlay grafts, bone pegs, or bone chips).

Surgical methods other than those recorded in the tables have also been used. For instance, Weigl (1949), Lange (1951), and Walter (1964) fixed the malleolar fragment by a metal clamp designed by Zuelzer (1948, 1951), and Küntscher (1953, 1962) designed an elastic spongiosa peg to be used for the same purpose. Forgon & Berenyi (1958) preferred to have the malleolar fragment fixed by a crooked kirschner wire that was drilled upward into the malleolus; it penetrated on the reverse side of the tibial bone at which site an elastic device was fitted which exerted traction on the wire and thereby compression on the fracture.

Table 3. Results obtained by surgical treatment of pseudarthrosis involving the medial malleolus.

Author	Pre-operative follow-up	Pseudarthrosis no. of cases	Postoperative osseous union no. of cases	Comments
Rieunau & Gay (1956)	?	2	2	Large tibial graft of specific form; applied as inlay graft
Berentey, Somogyi & Peer (1956)	3-11 months	2	2	
Tos (1960)	20 years	1	1	
Fischetti & Savoini (1965)	ca. 3 months	3	3	
Total		8	8	

Surgical method: Fibrous tissue not excised; application of bone transplants exclusively (inlay grafts).

According to Rostock (1938) it might be recommendable to use drilling according to Beck's method throughout the early stages of the process of fibrous union. Stotz (1943) abandoned this method, however, because it might fail to bring about union in many cases; Böhler (1957) did not find drilling an adequate procedure either.

If the malleolar fragments were sufficiently small, it might be justified, according to Stotz' opinion (1943), to have them extirpated. Boyd (1963) and Weber (1966) were also in favour of such treatment, always provided that the proximal portion of the malleolus was sufficiently large to keep the ankle joint mortise preserved.

It emerges from the numerous trials using different types of operation that the results obtained may not always have been as favourable as they seem to be according to Tables 1, 2, and 3; it can hardly be denied that the basis on which to evaluate the relative value of operations might have been more reliable if less selected series had been reported, above all if periods of observation prior to operation had covered intervals longer than six months. Such series are scarce, however, and thus a comparison cannot be made.

With a view to elucidating the problems involved in a surgical treatment of pseudarthrosis involving the malleolus, a review shall

be given of results obtained in a series of surgically treated cases. The patients concerned were followed for rather long periods of time, prior to as well as after operation.

In the present paper, malleolar pseudarthrosis is interpreted as nonunion of malleolar fractures at least six months after the time of accident.

AUTHOR'S SERIES

The following series have served as a basis for the study:

1. All surgically treated pseudarthroses of the malleolus, developed after fractures of ankles notified to the Directorate of Accident Insurance in Denmark in the period from 1945 to 1966: 16 cases.
2. All cases of pseudarthrosis of the malleolus surgically treated in the Orthopaedic Hospital in Copenhagen in the period from 1934 to 1968: 8 cases.
3. All cases of pseudarthrosis of the malleolus which prior to 1969 had been surgically treated in other orthopaedic and surgical departments in Denmark*: 13 cases.

The series comprise 37 lesions of ankles; pseudarthrosis involving the medial or lateral malleolus was exposed to surgery on 38 occasions (on one occasion, operation was performed on a bi-malleolar pseudarthrosis). Operation on account of pseudarthrosis of the medial malleolus had to be repeated in one case and thus, 39 operations were performed.

The series comprise 10 female patients and 27 male. Ages of patients at the time of accident varied from 10 years up to 72 years, averaging 34.0 years.

The pre-operative follow-up periods in all cases appear from Table 4, from which it will be seen that about 75 per cent of the cases were exposed to surgery at early stages. In general, the pre-operative periods of follow-up covered from six months up to 24 years, averaging 29 months.

It applies to all cases that operation apparently had been indicated on account of rather severe subjective symptoms such as pain in the

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Table 4. Pre-operative period of observation of pseudarthrosis involving the malleoli

	<i>Pre-operative period of observation In months</i>				Total
	6-8	9-17	18-24	> 24	
Medial malleolus	7	18	0	8	33
Lateral malleolus	2	2	1	1	6
Total	9	20	1	9	39

ankle when the patient was walking. In five cases operations were indicated because a post-traumatic dislocation of the ankle joint had to be corrected; it was in particular a reposition of the dislocated malleolar fragment that was required.

Operations on the Medial Malleolus

In 32 cases, the ankles were exposed to surgical treatment on account of pseudarthrosis involving the medial malleolus. Operation had to be repeated in one case, and a total of 33 operations were thus performed (Table 4).

Among the 33 operations on the medial malleolus were five which included extirpation of the malleolar fragment, and osseous union of the pseudarthrosis was attempted in the remaining 28 cases.

The primary results to be obtained by the various types of operation included in the latter category appear from Table 5. It emerges from this table that osseous union was obtained only in 18 cases out of 28. Still, in four of these cases, osseous union did not occur until more than four months after operation (in one case five months after and in the remaining more than one year after operation); thus, in these four cases, union can hardly have been a direct result of the operation.

In fact, the desired result was obtained only in 14 cases out of the 28 exposed to surgery (50 per cent).

The relative effect to be obtained by the individual types of operation can hardly be reliably evaluated because of the small number of cases. Results seemed to be optimal, however, if operation included excision of the fibrous tissue, restoration of fracture surfaces, fixation of the malleolar fragment, and application of bone grafts; using these procedures, healing was achieved in five cases out of six. In one case

Table 5. Incidence of union after the various surgical measures used in the treatment of pseudarthrosis involving the medial malleolus.

Type of operation	No. of cases	Duration of healing process		No. of cases in which union failed
		< 4 months	> 4 months	
Excision of fibrous tissue, restoration of fracture surfaces, fixation of malleolar fragment	7	4	0	3
Same as above, associated with application of autologous bone graft	6	5	0	1
Fibrous tissue not excised; fixation of malleolar fragment exclusively	3	0	1	2
Fibrous tissue not excised; application of autologous inlay graft	4	2	2	0
Application of heterologous bone graft (Kieler-bone)	2	0	1	1
Drilling of the pseudarthrosis	6	3	0	3
Total	28	14	4	10

in which this procedure failed to bring about healing, bone chips had been applied in the defect at the pseudarthrosis and the malleolar fragment had been fixed by a peg. This fixation may have been insufficient because osseous union had not yet occurred 11 months after the operation.

In cases in which the pseudarthrosis had not been excised and nothing except inlay grafts or bone pegs had been applied, healing immediately after operation was seen only in two cases out of four (Figure 1); in one case healing occurred five months after operation; in the other, healing was not achieved until more than one year later.

Results would be particularly poor if bone grafts were not applied (Figure 2) and also when bone grafts of heterologous type were used; results would be equally poor if drilling according to Beck's method was used (Figure 3). Among 18 cases exposed to the above measures, healing within four months after operation was seen only in seven.



Figure 1. Surgical treatment of pseudarthrosis involving the medial malleolus; application of autologous inlay graft; pseudarthrosis not excised. The photo to the left was taken in connection with operation; the one to the right was taken some months later.



Figure 2. Findings eight months after surgical treatment of pseudarthrosis involving the medial malleolus; the pseudarthrosis was excised and the malleolar fragment was fixed by a common screw.



Figure 3. Pseudarthrosis involving the medial malleolus; drilling according to Beck's method. The photo to the right depicts conditions 13 years after operation (the pseudarthrosis not healed up).

As already mentioned, fragments of the medial malleolus were excised on five occasions. In four of these patients, the pseudarthrosis was localized distally in the malleolus and in the remaining case, near the middle of the malleolus. Two of these cases were remarkable in that the malleolar fragment was seen to regenerate at a later stage, probably because it primarily had been removed via the subperiosteal route. Thus, the results obtained by operation were poor in these cases.

Examination at Follow-ups

Among 32 patients with surgically treated pseudarthrosis of the medial malleolus, four were not seen at follow-ups: one who had been exposed to bilateral amputation on account of diabetic gangrene and one in whom the talocrural arthrodesis had been excised on account of severe arthrosis; two patients had died. The remaining 28 patients met for follow-ups and were examined by the author.

Periods of observation were calculated from the time of operation until the time of follow-up and covered from 1 to 28 years, averaging 10 years and 2 months.

The roentgenological findings at follow-ups are recorded in Table 6.

Table 6. Roentgenological findings in 28 cases of surgically treated medial malleoli with fibrous union.

Roentgenological findings	Degree of Arthrosis			Total
	Absent	Mild	Marked	
Satisfactory	14	3	1	18
Less satisfactory	0	2	0	2
Poor	0	3	5	8
Total	14	8	6	28

The following criteria were used as a basis for the tabulated *classification of the roentgenologically results*:

Satisfactory: No visible dislocation.

Less satisfactory: Backward or forward displacement of the medial malleolus, not exceeding 2 mm. Dorsal and/or backward displacement, not exceeding 2 mm, of posterior tibial fragment. Normal position of talus and absence of other dislocations of the ankle joint.

Poor: Displacements more marked than those mentioned above.

The following criteria were used as basis for the tabulated *classification of arthrosis*:

Absence of arthrosis: normal joint space, absence of marginal osteophytes.

Mild arthrosis: Slightly reduced joint space and/or moderate but distinct formation of marginal osteophytes.

Marked arthrosis: Changes more severe than those mentioned above (reduction of the joint space will often be more marked and formation of marginal osteophytes more intense; subchondrial sclerosing may be manifest and the joint may occasionally be deformed).

It appears from the table that the incidence of arthrosis would be low if the ankle joint were not dislocated (according to the roentgenological picture: satisfactory result). This is consistent with the fact that dislocation of the joint rather than malleolar pseudarthrosis predisposes to arthrosis of the talocrural articulation (Sneppen 1969).

Table 7 illustrates the clinical findings at follow-ups of: patients in whom the pseudarthrosis had healed up, patients in whom the pseudarthrosis persisted, and patients in whom the malleolar fragment had been excised.

The following criteria were used as a basis for the tabulated *classification of the clinical findings*:

Table 7. Clinical findings at follow-ups of 28 patients with surgically treated pseudarthrosis involving the medial malleolus.

Status of medial malleolus	No. of cases	Subjective result			Objective result		
		Fair	Medium	Poor	Fair	Medium	Poor
Absence of pseudarthrosis	17	7	2	8	6	4	7
Presence of pseudarthrosis	8	3	3	2	5	1	2
Malleolar fragment excised	3	3	0	0	2	0	1
Total	28	13	5	10	13	5	10

Subjectively satisfactory: No complaints or only mild complaints to be provoked by excessive strain.

Subjectively less satisfactory: Complaints of more severe character to be provoked by excessive strain and/or regular complaints although not of a severity to interfere with the patient's normal activity.

Subjectively poor: Complaints of more severe character.

Objectively satisfactory: Essentially normal conditions.

Objectively less satisfactory: Mobility in at least one of the other joints of foot or ankle is reduced to about 1/3 or 2/3 of normal and/or muscular atrophy (about 1 cm) on crus or femur. Neither the foot nor the ankle are deformed. Normal gait.

Objectively poor: Mobility reduced to a higher degree and/or more severe degree of muscular atrophy; deformity of foot or ankle may be in evidence and the gait may be abnormal.

It appears from the table that findings in these three groups of patients did not differ, whether considered from a subjective or an objective point of view.

This is consistent with the fact that the presence of malleolar pseudarthrosis, together with the results obtainable by operation of such pseudarthrosis, does not influence the long-term prognosis in cases of fracture of the ankle (Sneppen 1969).

Operations on the Lateral Malleolus

In cases of pseudarthrosis involving the lateral malleolus, surgical measures were instituted only on six occasions.



Figure 4. Surgical treatment of pseudarthrosis involving the lateral malleolus; application of sliding graft; the pseudarthrosis was not excised. The photo to the left was taken shortly after operation, the one to the right was taken a few years later.

Ages of patients at the time of accident varied from 10 to 62 years, averaging 45 years. Follow-up periods prior to operation covered from six months up to five years, averaging two years and four months (Table 4).

The following types of operations were performed: the pseudarthrosis was excised and the malleolar fragment fixed in two cases; a sliding graft was applied in one of these cases. Osseous union occurred within about three months in both cases. In two cases, the fibrous tissue was not excised, but autologous inlay grafts exclusively were applied over the pseudarthrosis defect (Figure 4). In one of these cases, healing occurred within three months, in the other within about one year. In one case, drilling of the pseudarthrosis resulted in healing within about four months. In one case, a small malleolar fragment was excised.

Thus, the results obtained by surgery were satisfactory in all cases but one in which inlay graft exclusively had been applied and the pseudarthrosis had not been excised; healing in the latter case was not achieved until one year later.

Follow-up

The six patients who had been exposed to surgery on account of pseudarthrosis involving the lateral malleolus were all examined at follow-ups.

Periods of observation were calculated from the time of operation to the time of follow-ups and covered from one to 17 years, averaging eight years and eight months.

According to the roentgenological findings at follow-ups, results were found to be satisfactory in four cases and poor in two. In the latter two patients, the arthrosis was marked. Among patients in whom results were found to be satisfactory, one had a mild degree of arthrosis and one had marked arthrosis.

Considered from a clinical point of view, the subjective results were satisfactory in three cases and poor in another three; likewise, the objective results were satisfactory in three cases and poor in three.

DISCUSSION

Indications for surgical intervention: Whenever it is to be decided whether or not operation is indicated, it must be taken into consideration that symptoms of pseudarthrosis involving the malleolus are not characteristic; consequently, it may be difficult to determine definitely in the individual cases whether such symptoms actually are due to the pseudarthrosis or to other sequelae of the fracture. For that reason exclusively it may be open to doubt whether the symptomatology is influenced at all by such surgical treatment of the pseudarthrosis.

Furthermore, it must be taken into consideration that osseous consolidation of the pseudarthrosis does not contribute to a long-term relief of the patient's complaints, bearing in mind that the long-term prognosis of fractures of the ankle is not influenced by a malleolar pseudarthrosis (Sneppen 1969, 1971).

It will be observed that indications for a surgical treatment of malleolar pseudarthrosis rest on a rather frail foundation; consequently, rather than using surgical methods or techniques by which osseous union may be achieved only in about 50 per cent of the cases, it might be more advisable to abstain from operation in the case of malleolar pseudarthrosis.

On the assumption that a sufficiently effective surgical method is available, namely a method by which osseous healing might be obtainable in almost all cases, such a method is not indicated except in the very few cases in which the following requirements are fulfilled:

1. Other serious sequelae of the fracture must not be demonstrable by roentgen examination.
2. Operation must be performed at an early stage, preferably within

one year and not later than two years after the occurrence of the accident.

In the presence of post-traumatic dislocation of the ankle joint, indications for surgical treatment will be quite different and the therapy should be aimed primarily at a correction of such dislocation; in these cases, the pseudarthrosis is to be considered a complication of minor importance and surgical treatment of the pseudarthrosis should not be performed except if the malleolar fragment is dislocated; in the latter case, surgical treatment of the pseudarthrosis will be a natural component in measures by which to correct the dislocation.

Surgical Method

In connection with the survey of the literature on the matter (cf. Tables 1, 2, and 3), it was mentioned that the various types of operation had provided almost equally satisfactory results. It was postulated that these series were selected and also that the pre-operative periods of observation had been rather short in most cases, although the lengths of these periods had not always been stated.

The patients included in the author's series do not represent selected cases, and the long-term periods of observation prior to operation are well-defined. Consequently, these series may provide a better basis for an evaluation of results to be obtained in general by the individual methods.

In the light of the results recorded in Tables 5, it seems as though it might be advisable if surgery always included the application of autologous bone grafts, in the form of inlay grafts, bone chips, or bone pegs, in addition to the excision of the pseudarthrosis, the restoration of the fracture surfaces, and fixation of the malleolar fragment. Satisfactory results may also be obtainable by surgical techniques including the application of inlay grafts or bone pegs exclusively without excision of the pseudarthrosis.

Operations not involving application of autologous bone grafts are hardly recommendable in the treatment of these types of pseudarthrosis; this applies in particular to cases in which the malleolar fragment has been fixed by peg or common screw; drilling according to Beck's method is equally unfit.

In the presence of small fragments, the alternative procedure is probably extirpation of fragments and re-insertion of the ligament.

SUMMARY

On the basis of a review of 34 cases of surgically treated pseudarthrosis involving the malleolus (28 cases of pseudarthrosis involving the medial malleolus and 6 involving the lateral; postoperative periods of observation covered from one to 28 years) it is concluded that operation is indicated exclusively at early stages of lesions responsible for rather severe complaints which are not explicable as sequelae of the fracture other than pseudarthrosis.

Operations should always include the application of autologous bone grafts in excess of excision of the pseudarthrosis, restoration of fracture surfaces, and fixation of the malleolar fragments. In the presence of small malleolar fragments, the alternative measure should be excision of the latter.

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