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TRAUMATOLOGY OF THE FOOT AND  
THE ANKLE JOINT

LIGAMENT INJURIES OF THE ANKLE JOINT

by *Ragnar Magnusson* (Linköping, Sweden)

The ligaments of the ankle joint can be conveniently divided into two groups, which are distinctively different functionally and thus also traumatologically. The one group comprises those ligaments which attach the tibia and fibula to the talus and calcaneus, *i. e.*, the deltoid, anterior and posterior talofibular ligaments and the calcaneofibular ligament. To the second group can be assigned those ligaments included in the distal tibiofibular syndesmosis, namely, the anterior and posterior tibio-fibular ligaments and the interosseous ligament.

Injuries to the ligaments of the first group arise as a rule as alternative injuries to malleolar fractures, while ligament injuries in the second group almost always occur together with malleolar fractures and in certain cases are compulsorily attendant upon these.

With a supination trauma the first injury which may arise is a transverse fracture of the lateral malleolus. But if the trauma is of only slight or moderate degree, an avulsion of the fibular collateral ligament is found instead with or without a small shell-shaped fragment from the tip of the fibula. According to *Lauge-Hansen* it is the calcaneofibular and the posterior talofibular ligaments which are affected. Correspondingly it is possible with a pronation trauma to find the first injury to be an avulsion of the deltoid ligament instead of a fracture of the medial malleolus, so that the injury is very often localised to the insertion on the medial malleolus. Sometimes here too a small fragment may be avulsed from the tip of the malleolus. On clinical examination swelling and palpatory tenderness are usually found above the tips of the malleoli or above the ligament itself. Ruptures of the fibular collateral ligaments and of the deltoid ligament can be diagnosed radiologically by placing the foot in varus and valgus position; thus one can confirm an increased distance between the talus and the tip of the fibula between the talus and the medial

malleolus and confirm also that the articular surfaces of the tibia and talus do not run parallel with each other.

The most common injury in this group is undoubtedly rupture of the anterior talofibular ligament which occurs according to *Lauge Hansen* through inward rotation of the supinated foot. We all know the syndrome well, with swelling and palpatory tenderness above the lateral portion of the dorsal foot and above the sinus tarsi. According to *Lauge Hansen* a rupture of the calcaneocuboid ligament is also possible in such instances, sometimes with an avulsion fracture from the lateral portion of the calcaneus or from the cuboid. Injury to the anterior talofibular ligament and to the calcaneocuboid ligament cannot be diagnosed radiologically according to *Lauge-Hansen*. However an avulsion of the lateral portion of the calcaneus or of the cuboid may occur, according to the same author, and this can sometimes be seen on the X-ray.

In ankle joint distortion, injuries to tendon sheaths and joint capsules may also arise. Tendon sheath injuries are hardly likely to contain any serious complication. As far as injuries to the joint capsules are concerned, it is difficult to make any definite statement. Under certain circumstances they may possibly contribute to the manifestation of certain tendon trouble, but our knowledge of these matters is still too small for us to express an opinion on this with any great precision.

The group of ligamental injuries briefly discussed here is a very common group. Since the injuries are often considered to be trifling, they receive treatment corresponding to this approach, which often consists of the application of some form of elastic bandage, etc. It is undeniable that a great number of these patients become free from symptoms after such treatment or even without any treatment at all. This may be explained by the circumstance that a rupture may not always occur, but that the injury may confine itself to a strain or distension of the ligament. If a skeletal injury is excluded, the next step is to try and determine whether a strained ligament or ruptured ligament is involved. In differential diagnosis between these two types of injury to the collateral ligaments the gap demonstrated by *Lauge-Hansen* between the talus and the malleoli can be utilised, as this in all probability only occurs in total ruptures but not in strained ligaments. Here perhaps arthrography may help to shed light on a number of obscure points.

In a large series of ankle joint distortions *Broström* found that the prognosis for treatment with a simple supporting bandage was good, even if total rupture of the ligament was present. Other authors, e.g. *Francillon*, *Watson-Jones* etc., recommend immobilisation for 6 weeks for injuries to the collateral ligaments. It is in each case important to remember that a ligament requires a longer period to heal than a fracture.

With persistent insufficiency in a ligament instability arises and in consequence recurrent distortions may occur. Even a quite insignificant awkward step can give rise to new trouble and it is not rare to meet patients who incur a distortion merely by walking on a level, smooth city street. In the long run ruptures of collateral ligaments which do not heal cause deforming changes in the talocrural joints. In cases with frequent distortions suturing of plastics should be performed. For the latter purpose a number of methods have been evolved.

I shall now pass on to describe injuries to the second group of ligaments, the syndesmosis injuries. They may arise either as *isolated* injuries without simultaneous fracture or as injuries *compulsorily attendant* upon certain types of malleolar

fracture. An injury to the syndesmosis may either affect one of the ligaments, a partial syndesmosis, a total syndesmosis injury. In both cases pre-conditions exist for the appearance of a widening of the malleolar fork, a diastases. Whether a partial or total widening of the malleolar fork occurs, a lateral subluxation of the talus appears on weight-bearing by the foot.

The most common malleolar fracture is the oblique fracture of the fibula, which occurs through outward rotation of the talus when the lower leg is fixed. Before the fibula fracture establishes itself, there is *always* a rupture of the forward syndesmosis ligament, the anterior tibio-fibular ligament. It is anterior syndesmosis injury which determines the appearance of the oblique fracture of the fibula. With this type of malleolar fracture on the other hand the posterior syndesmosis ligament always remains intact.

The injury to the forward syndesmosis ligament arises most often as an avulsion fracture from the tibial attachment, the anterior tubercle of the tibia, but may also occur as a pure soft tissue injury or as an avulsion fracture from the attachment on the fibula. The small shell-shaped fragments which are avulsed from the tibia are too tiny to be seen on the X-ray picture when the injury occurs. If the avulsion fracture does not heal, sclerosis occurs in the small avulsed fragment and this makes the fragment visible after a time in the frontal X-ray picture. On X-ray examination of the foot in 45° outward rotation the anterior tubercle is projected free and then a possible pseudarthrosis can be obtained on the X-ray picture. When the ligament is avulsed from the tibia without a bony fragment, one can after a time see changes in the contour of the anterior tubercle of the tibia.

With a pronation trauma the first injury to occur is a transverse fracture of the medial malleolus or a rupture of the deltoid ligament. The second injury is a syndesmosis injury comprising both the anterior and the superior syndesmosis ligaments, a total syndesmosis injury. With a pronation trauma, as is well known, the fibula fracture may occur in any part of the fibula at all, even subcapitularly. With the high types of fracture, there is according to *Lauge-Hansen* an injury on both anterior and posterior syndesmosis ligaments and also a rupture of the interosseous ligament. With the more distally sited pronation fractures the same author finds injury only to the syndesmosis ligaments while the interosseous ligament remains intact.

In a further type of malleolar fracture rupture of the anterior syndesmosis ligament occurs, *i. e.*, with the quite uncommon bimalleolar supination fractures with medial subluxation of the talus. In these fractures an avulsion occurs of the anterior and probably also of the posterior syndesmosis ligament, but on the other hand no syndesmosis rupture, which is important to remember. In this type of fracture the distal fibula fragment always follows the talus with medial dislocation.

It is easy to diagnose syndesmosis injuries with simultaneous occurring fractures. As soon as the etiological diagnosis of the fracture is clear, then one also knows what kind of syndesmosis injury is present. It is probably unusual to see a syndesmosis injury in such cases offers great difficulty. A symptom which arises however is swelling and palpatory tenderness above the anterior portion of the syndesmosis. This symptom is very characteristic but clearly quite unfamiliar.

The attempt has been made to deal with the difficulties in the diagnosis of the syndesmosis injuries by means of a few radiological methods. On the one hand a number of measuring methods exist, which are all variations on the same theme,

that is, to measure in different ways the distance between the tibia and the fibula, and on the other hand diagnosis of syndesmosis injuries by means of arthrography has been attempted. It would take too much space to describe these methods in more detail in this connection. One may say briefly of the measurement methods that the sources of errors are too many for the method to give reliable results and as far as the arthrography is concerned, that it is a little too involved and that it is hardly suitable for an out-patient practice where it otherwise would have its greatest value. It is then really simpler after anaesthesia of the joint to carry out lateral dislocation movements under X-ray control in order to discover if the talus can be successfully dislocated. I will instead once again emphasise the extreme importance of mastering the etiological diagnostics of malleolar fractures. Then one need have no worry about finding out whether a syndesmosis rupture exists or not and, if it is present, then one also is aware of what it comprises.

The treatment of a fresh *syndesmosis injury without fracture* consists in immobilisation of the foot in the inward-rotated position for at least 6 weeks. With *simultaneous fracture* the treatment of syndesmosis rupture and fracture coincides. For immobilisation of the foot, whether after open or closed reduction of the fracture, the foot must be placed in the position which makes possible healing of the syndesmosis injury. For outward-rotated fractures the foot must be therefore fixed in the inward-rotated position and for pronation fractures in the supination position. The period of immobilisation must naturally be adapted to the severity of the fracture.

Swelling and palpatory tenderness above the anterior aspect of the syndesmosis, that is, the symptom which I have mentioned as typical of a fresh syndesmosis injury, may remain over long periods and is then a sign that the syndesmosis injury is not healed. The patient's subjective symptoms in this respect are often a feeling of uncertainty on walking, stiffness and pain in the ankle joint. Swelling around the ankle joint often occurs, especially in association with exertion, and this is a symptom of an initial deforming arthrosis. As far as the incidence of deforming changes in the ankle joint is concerned, it should be stated that amongst 118 cases of unimalleolar outward-rotation fractures there were 35 cases with arthrosis deformans in the injured ankle joint, equal to 29 per cent. The observation period was on average 5½ years. *Watson-Jones* spreads a dangerously false opinion therefore, when he states in his book on fractures that for the treatment of this type of malleolar fracture "it matters little what is done".

The idea has begun to gain acceptance that the normal width of the malleolar fork should be restored when there is a diastasis in the fork. Various surgical procedures have been utilised for this purpose. The most common is probably to fix the fibula to the tibia with a wing screw. This procedure has the disadvantage that it is difficult to judge how much the screw should be tightened. If it is tightened too severely, then less width will be found in the syndesmosis than is normal with the accompanying loss of the elasticity normally present in the syndesmosis. This can produce difficulties in the gait when walking. A loop of steel wire may also be utilised to fix the fibula to the tibia, a procedure which does not perhaps provoke the same silent resistance in the talus' movements in the fork as may be the case when the screw is used. Before any of these procedures are utilised however, one should first of all see whether any ligament rupture present can be sutured or whether the pseudarthrosis which may possibly have arisen within the anterior tubercle of the

tibia can be treated. *Cedell & Wiberg* have noted well the danger of a permanent diastasis and with fresh outward-rotation fractures they have performed cerclage on the fibula and treated the syndesmosis rupture by fixation with a metal clamp or by suturing the syndesmosis ligament and with subsequent immobilisation for 6-8 weeks. The syndesmosis injuries surgically treated up to this point are either too small in number or as in *Cedell & Wiberg's* series, too little time has passed for any evaluation of the different methods to be made.

I have tried to make a brief survey of the diagnostic and therapeutic problems, which meet us in injuries to the ligaments of the ankle joint. It is clear that there is much to add, but I hope that the coming discussion will give more comprehensive information about the interesting complex of problems called *the traumatology of the ankle joint*.

#### TREATMENT OF MALLEOLAR FRACTURES

by *Kauko A. Solonen* and *Leo Lauttamus* (Helsinki)

Fractures of the ankle have often been dealt with in the literature, and a number of valuable studies have been made by Scandinavians (*Husfeldt* 1938, 1939, *Lauge Hansen* 1942, 1948, 1949, 1953, 1956, *Magnusson* 1944, 1945, *Palmer* 1946, 1950, 1961, *Kristensen* 1949, 1953, 1956, *Biström* 1952, *Vasli* 1957, *Grath* 1960, *Klossner* 1962). When undertaking to describe, in the following, experience obtained in the treatment of fractures of the ankle, we make no claim to a new method nor do we promise a parade of brilliant results. We have worked on traditional lines and quite possibly some other writers may be able to present better end results. The purpose of the study has been to scrutinize our own work and to discover where mistakes have been made.

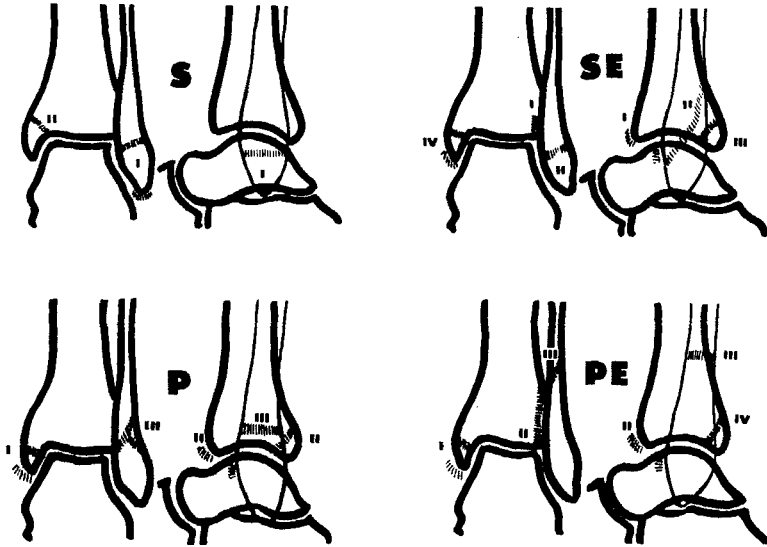
The fractures are here classified according to the Lauge Hansen-Palmer system, the one most commonly used in the Scandinavian countries, in which the groups are clearly distinct and which is logical and serviceable (Fig. 1).

Malleolar fractures, besides being dependent on the nature of the trauma and other injury mechanism involved, are also to a great extent conditioned by the ligamentous anatomy of the ankle. It may be said that were it not for problems of the ankle ligaments, the treatment of malleolar fractures would present no great difficulty. Quite often injury done to the ligaments is of much more significance than the fracture after which the damage is named. On the whole, injuries to the malleoli and the ligaments occur simultaneously with and are equally significant components of damage caused to the ankle.

#### *Material.*

The study is based on two groups of cases, an older series, which was examined during the course of a number of years and a more recent series of which only the primary results have been analysed. The older series derives from a time when the Clinic was housed in the same building with two other clinics, and most of the fractures were treated primarily by general surgeons. The newer series was treated at the Clinic for Orthopaedics and Traumatology.

In all, 821 patients with fractures of the malleoli, treated in the years 1950-1963, were examined. The figure omits the out-patients treated within the same period. In



*Fig. 1.*

Lauge Hansen-Palmer classification of injuries to the ankle.

S = Supination.

SE = Supination-external rotation.

P = Pronation.

PE = Pronation-external rotation.

some of the cases included in the series, not of a severity to necessitate hospitalization, the patients were admitted to the hospital because of other contemporaneous injury.

The series consists of an almost equal number of men and women, but the two sexes show considerable divergence in age distribution. Of the women 4/5 were 40 years old or more, of the men only one half. Of the women a third were 60 years or more, of the men only 1/10 were of that age.

The first series, observed during a longer period of time, comprises 238 patients treated in 1950-1960. Of these, 116 patients (about 49 per cent) presented themselves at follow-up examinations. The distribution of fractures of this group of cases into types and degrees is shown in Table 1. The cases that were followed up will be seen in Table 2. The distribution of the follow-up series among different types of fractures, as appears from the Table, corresponds with the ratio in the whole series. The exceptionally large share of the pronation-external rotation fractures (PE; 27 per cent) attracts attention. In other series published the percentage has ranged between 7 and 23. The time that elapsed between the injury and the follow-up was 2-12 years. Judging from the primary results, in most of those who did not present themselves for follow-ups the end results were good, i.e. our follow-up results give an unfavourable picture of the results of treatment. The distribution of the newer series among different types is shown in Table 3.

TABLE 1  
*Distribution of fractures among the various groups and stages (1950-1960).*

Fracture group*	Stages			Total	%
	II	III	IV		
S .....	22	-	.	22	9
SE .....	2	9	108	119	50
P .....	6	17	.	23	10
PE .....	-	9	47	56	23
Irregular .....	.	.	18	18	8
<b>Total .....</b>				<b>238</b>	<b>100</b>

\*S = Supination.

SE = Supination-external rotation.

P = Pronation.

PE = Pronation-external rotation.

TABLE 2  
*Follow-up series (1950-1960).*

Fracture group	Number of patients	%
S .....	9	8
SE .....	58	50
P .....	11	9
PE .....	31	27
Irregular .....	7	6
<b>Total .....</b>	<b>116</b>	<b>100</b>

TABLE 3  
*Distribution of fractures among the various groups and stages (1961-1963).*

Fracture group	Stages			Total	%
	II	III	IV		
S .....	5	44	.	49	8.4
SE .....	16	8	327	351	60.2
P .....	21	23	.	44	7.5
PE .....	1	15	91	107	18.4
Irregular .....	.	.	32	32	5.5
<b>Total .....</b>				<b>583</b>	<b>100.0</b>

*Treatment.*

Of the older series (238 cases), 191 (80 per cent) were treated conservatively and 47 (20 per cent) by operation. In recent years operative treatment has been resorted to nearly twice as often as earlier. Of the 583 patients in the new series 214 were operated upon (37 per cent) and in 369 cases (63 per cent) the treatment was conservative.

*Conservative treatment.*

No clear-cut indications were followed in the choice of operative procedure; the aim was to select the method considered the most appropriate in each individual case. The largest group operated upon was that in which the attempt to treat the damage conservatively had led to an unsatisfactory outcome. The commonest reasons for this were interposition in the fracture of the medial malleolus, syndesmotic rupture and a large fragment of the posterior tibial margin. In many cases repair of the fracture was accompanied by suturation of a ligamentous rupture. The ligament in question was usually l. deltoides. In three cases a primary talocrural arthrodesis was carried out with a good result. All the ankles operated upon were immobilized in plaster of Paris in the same manner as those treated conservatively. A walking cast was applied in both series in about two-thirds of the cases 4-6 weeks after the primary treatment.

*Results.*

The primary result (result after the end of the primary treatment) was evaluated from roentgenograms and case records. The end result was evaluated in the follow-up. (We are personally responsible for all the evaluations). The results have been classified as good, fair and poor.

In the primary estimate a roentgenographically good result was taken to mean exact reduction of the medial and lateral malleoli and talus. In addition, the result was considered good if the fractural line in the medial malleolus was open 2 mm at the most in the ventral direction, the fragment of the lateral malleolus had not shifted more than 1 mm proximally or dorsally. The fragment of the posterior margin measuring less than  $\frac{1}{4}$  of the width of the distal articular surface of the tibia, measured on the lateral aspect, was not to be dislocated upwards more than 2 mm at the utmost. For a fair result an accurate reduction of the talus was required, a widening of 1 mm at the most in the ankle mortise and a shift of not more than 2 mm of the fragment of the lateral malleolus in the proximal or dorsal direction, or a distal or anterior dislocation of the fragment of the medial malleolus not exceeding 2 mm or a not more than 2 mm displacement upwards of the large fragment of the posterior margin. Results inferior to these were considered poor primary results roentgenographically. A roentgenographic late result was estimated as good if a good reduction result of the kind described was recorded, with only slight arthrosis. The late result was fair roentgenographically if only slight arthrosis was present in connection with the above satisfactory reduction or severe arthrosis concurrent with a good reduction result. Results inferior to these were estimated as poor.

The cases were estimated as clinically good if the injured ankle was equivalent to a sound one. Clinically fair were the cases in which no deformity of the ankle was revealed, and in which the dorsal and plantar flexion of the ankle was at least one

TABLE 4  
Results of treatment (1950-1960).

Fracture group	Primary result			Late result								
	Good	Fair	Poor	Subjective			Clinical			Radiographic		
				Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
S .....	2	3	4	4	4	1	5	2	2	1	6	2
SE .....	27	13	18	36	18	4	39	12	7	24	15	19
P .....	7	3	1	9	1	1	9	1	1	6	4	1
PE .....	15	8	8	19	8	4	22	4	5	13	9	9

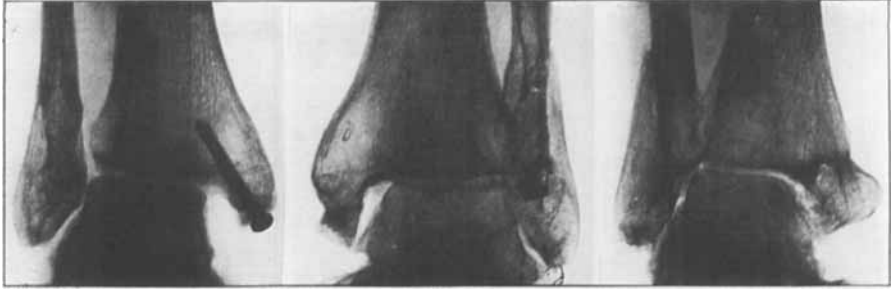


Fig. 2.

Who would believe that these ankles are subjectively excellent several years after the injury has occurred?

half of the corresponding mobility of the sound one. Walking on the floor and on stairs had to be faultless and there was to be no pathological mobility of the ankle. All cases with characteristics inferior to these were recorded as poor.

The subjective late result was good if the patient reported slight discomfort at the most from great exertion, fair if great exertion resulted in significant discomfort or if the daily discomfort was slight and did not affect the patient's capacity for work. Results inferior to these were classified as subjectively poor. The subjective late result is probably the most significant, in spite of diverging unexpectedly from the impression obtained from roentgenograms. It is the latter that shows most clearly the degree of success attained in the treatment (Fig. 2). A greater number of good and fair results was obtained by subjective evaluation than clinically and by roentgenography. A comparison of the primary results with the roentgenographic late results—these being the ones best comparable—shows no significant changes, in the course of the years, in the grading of the end results (Table 4).

TABLE 5  
*Summary of the late results.*

Fracture group	Good	Fair	Poor	Total
S .....	1	4	3	8
SE .....	21	29	9	59
P .....	5	4	2	11
PE .....	9	14	8	31
Irregular .....	2	4	1	7
<b>Total .....</b>	<b>38</b>	<b>55</b>	<b>23</b>	<b>116</b>
<b>% .....</b>	<b>33</b>	<b>47</b>	<b>20</b>	<b>100</b>

In summarizing the end results, an ankle which is good subjectively, clinically and in the roentgenogram is recorded as good. An ankle which has been not less than fair according to all standards of estimation is entered as fair. The result is considered poor if estimated poor according to even a single criterion. The synthesis of

TABLE 6  
*Primary results in the later series (1961-1963).*

Treatment	S		SE		P		PE		Irregular			
	Good	Poor	Good	Poor	Good	Poor	Good	Poor	Good	Poor		
Conservative .....	28	2	153	30	21	5	31	10	9	13	5	1
Operative .....	15	2	70	10	9	3	38	12	7	9	3	1
Total .....	43	4	223	40	30	8	69	22	16	22	8	2

the final results is found in Table 5 and shows 33 per cent of definitely good results, 47 per cent of fair and 20 per cent of poor results.

When the results are examined by types of fracture, the poor results of fractures in group S are found to be due to incidental complications and unsatisfactory early treatment given elsewhere.

The good results obtained for SE fractures have persisted. Part of those that were fair primarily have been good at follow-up. Even the roentgenographic result has sometimes improved, new bone filling up bone defects left after primary treatment, such as are due to rise of the posterior marginal fragment of the tibia or a shift of the malleolar fragment. In group SE only slight widening of the malleolar mortise caused by a partial syndesmotic rupture was present, but in most cases the unsatisfactory results seemed to be traceable to the residual dislocation of the fragment of the lateral malleolus. The results of the fractures in group P had persisted.

The PE fractures often showed a poor result which was due to an insufficient syndesmosis and lateral subluxation of the talus. In three cases a late arthrodesis proved necessary. The primarily good and fair results had persisted.

The results are better in the new series (Tables 6-7). A good result was obtained in 66 per cent, a fair one in 22 and a poor one in 12 per cent of the cases. In this material, good, fair and poor results were obtained in the same ratio in the groups treated conservatively as in those in which the patients were subjected to operation.

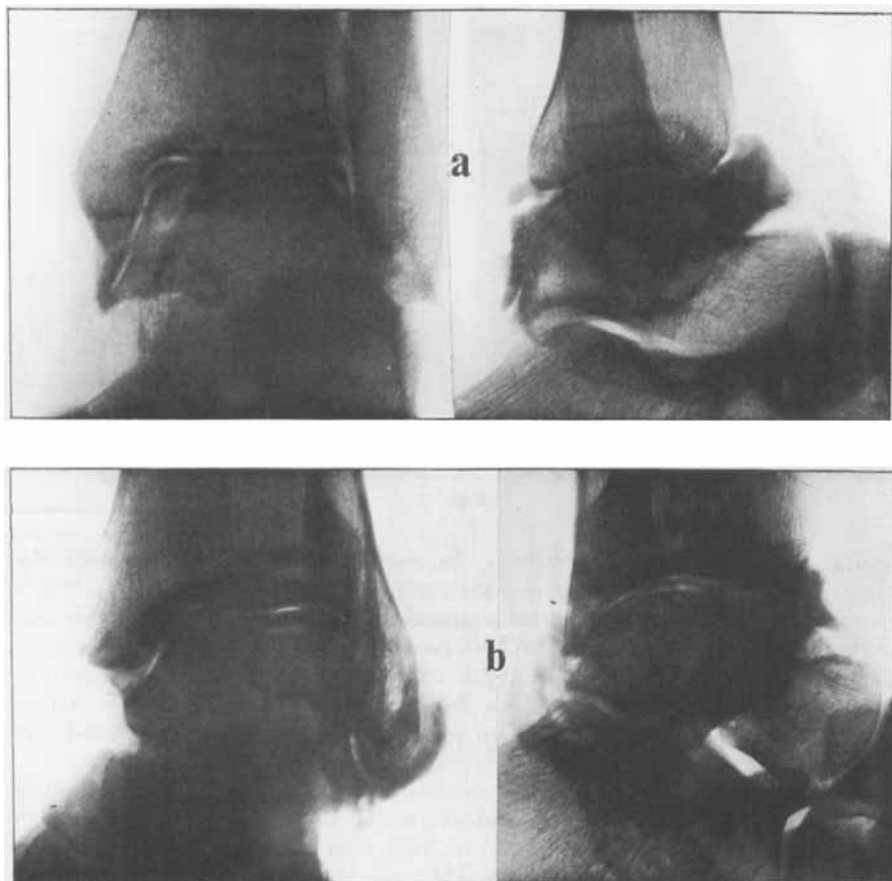
TABLE 7  
*Summary of the primary results (1961-1963) (%)*.

Fracture group	Good	Fair	Poor
S .....	88	4	8
SE .....	64	25	11
P .....	68	18	14
PE .....	64	21	15
Irregular .....	69	25	6

The fractures not represented in the Lauge-Hansen system (irregular fractures), 6 per cent in the older material, 5½ per cent in the newer, were not examined in detail. The whole series, it should be mentioned, contains about 5 per cent of unanalysed open fractures.

#### *Discussion.*

In about 20 per cent of the cases two or more reductions had to be performed, if those undertaken on the same occasion are counted as one procedure. Judging from the frequency of the procedures the fractures of group PE were the most difficult to treat. The great number and differing qualifications of the surgeons participating in the treatment must of course have affected the results. Secondary arthrosis, not always ascribable with certainty to the injury in question, was revealed by roentgenography in 61 per cent of the patients followed up. This is an exceptionally high percentage. The relatively higher incidence of arthrosis in the patients operated upon than in those treated conservatively, also appears exceptional. Whether this is to be



*Fig. 3.*

Arthrographic findings.

- (a) A normal ankle. (b) Rupture of the lateral collateral ligaments.  
(c) A syndesmotic rupture.

attributed to the fact that only the most severely injured ankles were subjected to surgery, as well as ankles on which conservative treatment had been attempted in the first instance, or to the procedure itself, remains an open question.

A widened tibiofibular syndesmosis was revealed in more than 27 per cent of the cases in the older series and in 14 per cent in the newer. Most of the cases occurred in consequence of fractures of group SE. Of the cases of the SE group 33 per cent showed some degree of syndesmotic widening. The condition was of almost equal relative frequency but in a severer stage in group PE, and rare in group P. As can be concluded from this distribution among the different groups, the majority are partial ruptures, mainly ruptures of the anterior tibiofibular ligament (SE). A widening of 1-2 mm on the whole does not seem to cause any subjective discomfort. This is also the view expressed by *Klossner*, among others. Primary detection of a

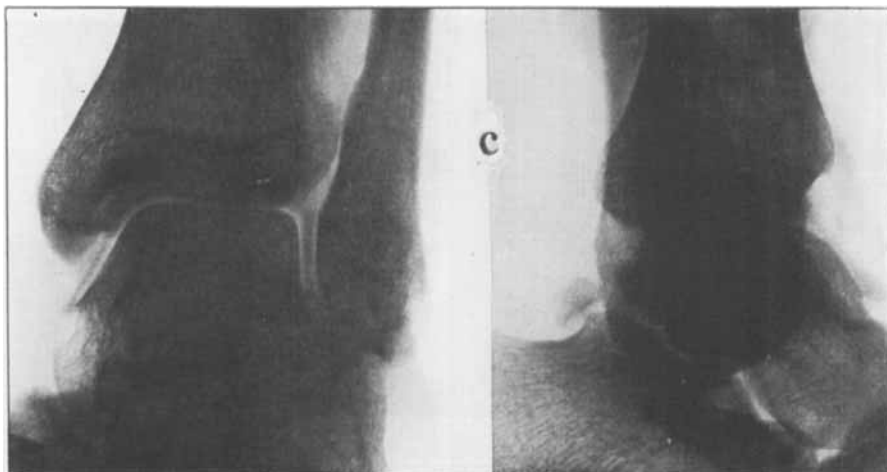
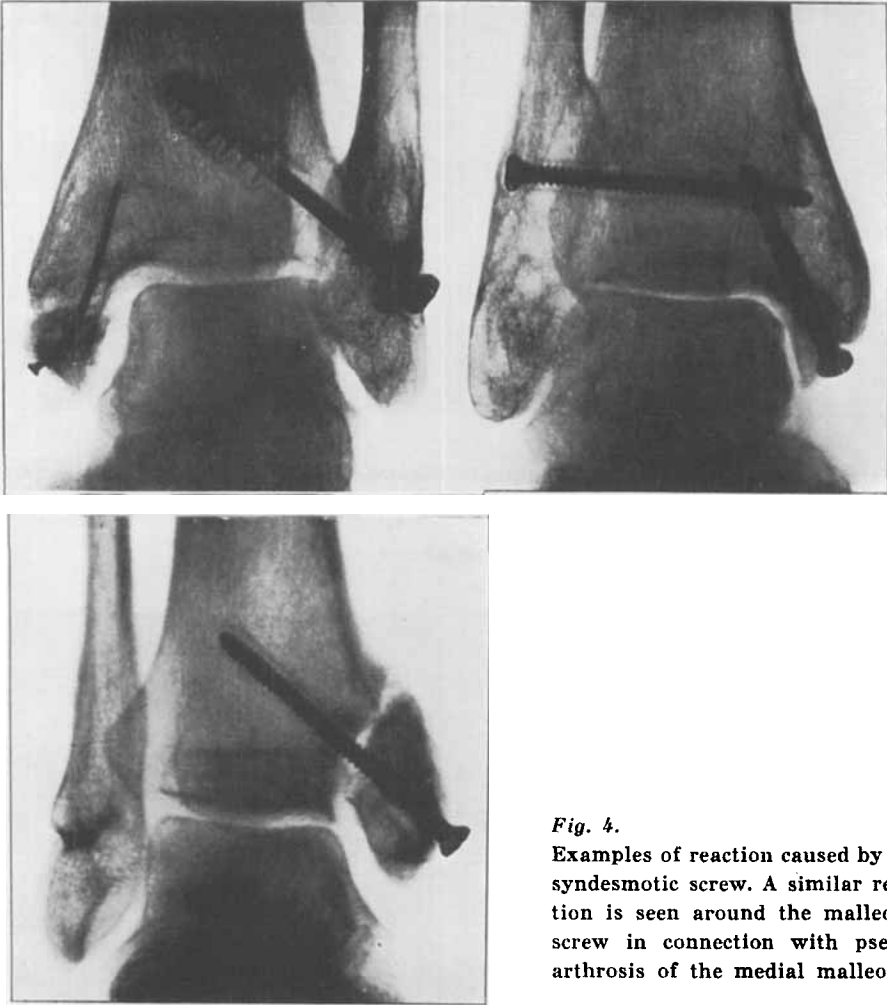


Fig. 3.

partial syndesmotomic rupture is often considered difficult and many methods have been suggested to facilitate diagnosis (*Chaput 1908, D'Aubigne & Smets 1934, Felsenreich 1937, Johansson 1938, Husfeldt Magnusson 1944*). Even arthrography has been utilised (*Wolff 1940, Hansson 1941*). Yet familiarity with the Lauge-Hansen classification seems to resolve the difficulty in a satisfactory way and makes special measures of examination superfluous. *Quigley (1959)* recorded a similar view. Arthrography is not out of place but its best use is in revealing ruptures of the lateral collateral ligaments (Fig. 3).

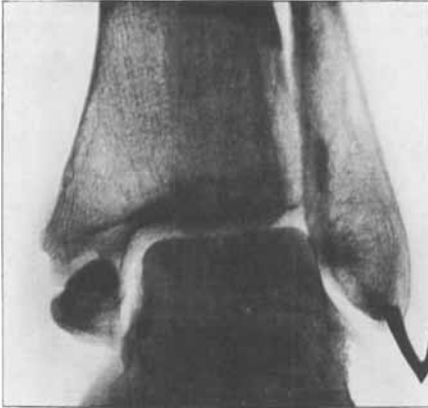
It has been claimed that it is possible to omit removal of the appliance of fixation, a screw or a bolt, without causing restriction of mobility or other noteworthy inconvenience. (*Costigan 1953, Mullins et al. 1958, Grath, Smith 1963*), but a number of dissident views have been recorded (*Allredge 1940, Burns 1942, Lee & Horan 1943, Bonnin 1950, Close 1956*). Our follow-up series contained patients with a broken fixation screw, and a few others with ossification of the syndesmosis; in others, on the other hand, a reaction of the bone tissue around the screw was revealed along with resorption of the bone and surrounding sclerosis. The findings were similar whether the screws applied were of steel or vitallium. None of these patients were wholly free from subjective symptoms. In the newer series the same findings were revealed in 22 cases, *i.e.* in most of the cases in which the screw was retained. The reaction in the bone tissue surrounding the screw was revealed by roentgenography at the earliest after the lapse of three weeks from the operation. No reaction was seen in any instance around the malleolar screws with the exception of one case with a mobile pseudoarthrosis in the malleolus (Fig. 4). It would appear that in our series repair of a syndesmotomic lesion or fixation of the syndesmosis was carried out too infrequently. On the other hand, we are assured that the syndesmotomic screw should preferably be extracted before weight-bearing. The movement of the fibula in the direction of its longitudinal axis, around it and in the mediolateral direction is surely not without significance for the functioning of the ankle, although in some cases, if eliminated, subjectively insignificant symptoms are produced.



*Fig. 4.*

Examples of reaction caused by the syndesmotic screw. A similar reaction is seen around the malleolar screw in connection with pseudarthrosis of the medial malleolus.

Ligamentous lesions were present, according to Lauge-Hansen's classification, in the majority of our cases, *i.e.* in all fractures of group SE, P and PE. Yet only one instance of clinical insufficiency of the ligaments was revealed in the follow-ups. No specific roentgenography was carried out to demonstrate ligamentous insufficiency. The great number of instances of syndesmotic widening and dislocations of the lateral malleolus should, however, be ascribed to omissions in the treatment of the ligamentous damage. In our opinion ligamentous ruptures should be sutured unless the treatment of the fractures quite obviously makes it possible for the ligaments to be restored anatomically. Experiments suggest that quicker and better regeneration of the ligaments is achieved by suturation than through cicatrization (*Clayton et al.* 1959). Some instances of ossification of the ligament were revealed after the ligamentous rupture (*Fig. 5*). Omission of an exact reduction and retention of the lateral



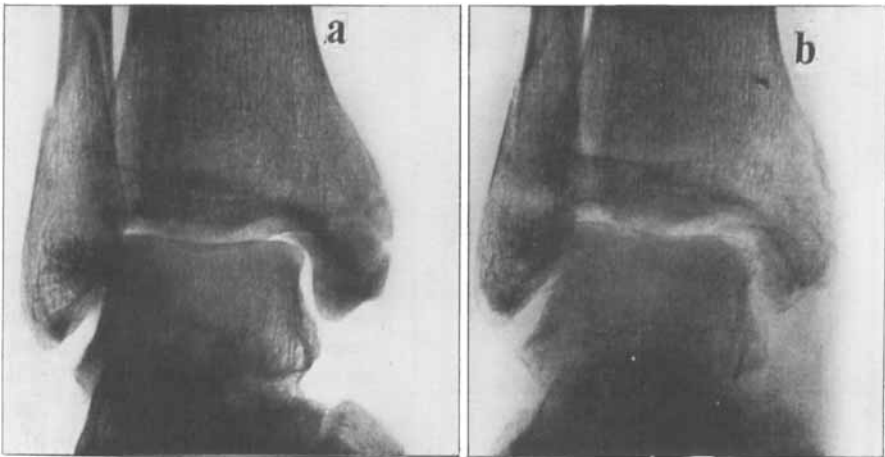
*Fig. 5.*



*Fig. 6.*

*Fig. 5.* Pseudarthrosis of the medial malleolus unaccompanied by subjective discomfort.

*Fig. 6.* Ossification of the deltoid ligament after a malleolar fracture.



*Fig. 7.*

(a) Initial roentgenogram in a man, nineteen years old, after the injury.

(b) Regional bone atrophy nine weeks later.

malleolus in cases of ligamentous or syndesmotic rupture was one of the commonest causes of an unsatisfactory result. After fixation of the medial malleolus exact reposition of the fracture of the lateral malleolus could be effected in most cases, but if fixation of the lateral malleolus was omitted, dislocation, especially rotation, frequently occurred. It seems that in fractures of group SE, for instance, the best result is achieved by operative repair of both the ligamentous damage and the fracture of the lateral malleolus. The advisability of this kind of treatment has been emphasized

by many writers in the past (*Palmer, Rudberg 1953, Proctor 1954, Vasli, Bergkuist et al. 1958, Cedell et al. 1962*).

Pseudarthrosis of the medial malleolus (Fig. 6) was revealed in 8 per cent of the follow-up cases. It was always interpreted as implying a poor roentgenographic result. Yet only one-tenth of these patients complained of discomfort that could be clearly traced to the medial malleolus. Severe fibrosis may, it seems to us, counterbalance damage to bone tissue even in cases with a large fragment. Different opinions have earlier been expressed about the significance of the pseudarthrosis of the medial malleolus (*Laurent 1956, Nigst 1961, Frankel et al. 1963*).

Pseudarthrosis of the lateral malleolus was present in one case.

Aseptic necrosis of the fragment of the medial malleolus occurred in four cases without causing any noteworthy discomfort.

The large fragment of the posterior margin of the tibia remained dislocated in 8½ per cent of the cases in the old series and in 2½ per cent in the new series, after treatment. This fault gives rise to a poor result. In most cases the dislocation can only be treated by surgery. More than one or two screws or nails may be required for retention of the fragment. In connection with fractures of group SE the dislocation of the fragment of the posterior margin is often reparable by means of an exact reduction and retention of the fragment of the lateral malleolus, for the two fragments constitute a fractural whole.

Pes planovalgus was recorded in 11 per cent at follow-up, bilateral deformities being left out of account.

The following incidental complications impaired the result: splitting of the fragment at operation, insufficient fixation of the fragment leading to redislocation, too restricted an operative approach, lesion of the articular surface of the talus, other primary traumatic complications of the fractures, which in some instances ruled out operative treatment and the achievement of a good result. Severe bone atrophy after the fracture and immobilization was sometimes the cause of delayed recovery (Fig. 7).

No additional operative complications occurred with the exception of some cases of marginal necrosis of the wound, due to a faulty, clumsy technique, incorrect timing of the operation or a poor plaster cast. It is well known that in the treatment of malleolar fractures the surgeon's technique in making plaster casts is put to an exceptionally severe test. Now and then redislocation of the fracture due to an inferior plaster was revealed. The previously described periods of immobilization appear to have served the purpose. A walking cast is often helpful but in some cases the result was found to have been impaired through its use. In these cases the fracture had been too unstable to permit treatment by this means.

#### *Conclusions.*

Primary results persisted on the whole but secondary arthrosis sometimes impaired an ankle which was believed to have been completely restored.

A good result presupposes an accurate diagnosis, achievable only if the whole extent and genesis of the damage is understood. It is a matter of damage to several components of a complex joint and not only of fractures of the bone.

In the absence of contraindications treatment should be operative, if good reduction and secure retention have not been produced by the conservative treatment. External rotation fractures (SE II-IV and PE II-IV) should presumably always be treated by surgery. A widening of the syndesmosis should be repaired. The fixation

appliance used on the syndesmosis should be removed before walking without support.

At operation an accurate reduction and stability should be achieved. For this result an open repair of more than one component of the injury is usually required. In all cases conservative reduction must be carried out at the earliest possible moment to prevent disturbance of the circulation and its consequences. Correct timing is important when surgery has been decided on.

Ligamentous ruptures should be sutured unless treatment of the fractures quite obviously makes it possible for the ligaments to be restored anatomically.

Accurate repair of the fracture of the lateral malleolus is as important as that of the medial malleolus.

The plaster cast should ensure good immobilization during the whole course of the treatment and be well moulded. A walking plaster may be applied at the final stage of the treatment when the syndesmosis is firm and no significant fracture of the weight-bearing articular surface of the tibia is present.

Primary arthrodesis is sometimes indicated. A good result is not always achievable but should always be aimed at.

#### *Summary.*

Experience obtained in the treatment of 821 cases of malleolar fracture is described. Both primary and late results are evaluated. Conservative and operative treatment were used. The results of treatment were good or fair in 80-88 per cent of the cases. The result obtained by primary treatment was found to persist although in some cases it was impaired through arthrosis in the course of time.

Success is achieved only through full understanding of the genesis and extent of the damage and treatment of all its components. Damage to soft parts, especially lesions of the syndesmosis and the ligaments, must be treated. Surgery seems to be indicated in more cases than has been supposed hitherto, especially in the repair of damage due to external rotation and specifically in the repair of syndesmotic and ligamentous ruptures and fractures of the lateral malleolus.

#### *References.*

- Allredge, R. H.*: Diastasis of the Distal Tibio-fibular Joint and Associated Lesions. *J. Amer. med. Ass.* 115: 2136, 1940.
- Bergkvist, A., Hultengren, N., Lindholm, A. & Lindvall, N.*: Circumferential Wire Fixation of the Lateral Malleolus for Fractures at the Ankle. *Acta chir. scand.* 115: 476, 1958.
- Biström, O.*: Conservative Treatment of Severe Ankle Fractures. *Acta chir. scand. Suppl.* 168, 1952.
- Bonnin, J.*: Injuries to the Ankle. William Heinemann, Medical Books Ltd., London, 1950.
- Burns, B. H.*: Diastasis of the Inferior Tibio-fibular Joint. *Proc. roy. Soc. Med. (Sect. Orthop.)* 36: 330, 1942.
- Cedell, C.-A. & Wiberg, G.*: Treatment of Eversion-Supination Fracture of the Ankle. (2nd Degree). *Acta chir. scand.* 124: 41, 1962.
- Chaput*: Quoted by Magnusson.

- Clayton, M. L. & Weir, G. J.*: Experimental Investigation of Ligamentous Healing. Amer. J. Surg. 98: 373, 1959.
- Close, J. R.*: Some Applications of the Functional Anatomy of the Ankle Joint. J. Bone Jt Surg. 38-A: 761, 1956.
- Costigan, P. G.*: Treatment of True Widening of Ankle Mortise. Canad. med. Ass. J. 69: 310, 1953.
- D'Aubigne & Smets*: Quoted by Magnusson.
- Felsenreich, F.*: Schlottergelenke nach Malleolarfrakturen. Arch. orthop. Unfall-Chir. 37: 149, 1937.
- Frankel, C. J., McCue, F. & Humphries, D.*: Injuries to the Ankle. South. M. J. 56: 402, 1963.
- Grath, G.-B.*: Widening of the Ankle Mortise. Acta chir. scand. Suppl. 263, 1960.
- Hansson, C. J.*: Arthrographic Studies on the Ankle Joint. Acta radiol. 22: 281, 1941.
- Husfeldt, E.*: Behandling af Malleolarfrakturer. En Efterundersøgelse af 140 Tilfælde. Hospitalstidende 81: 717, 1938.
- Husfeldt, E.*: Diagnosen af Bristning i Syndesmosis tibiofibularis og dens Betydning. Nord. Med. 4: 3830, 1939.
- Johansson, S.*: Några ord om behandling av fotledsfrakturer. Hygica 100: 248, 1938.
- Klossner, O.*: Late Results of Operative and Non-operative Treatment of Severe Ankle Fractures; A Clinical Study. Acta chir. scand. Suppl. 293, 1962.
- Kristensen, T. B.*: Treatment of Malleolar Fractures According to Lauge Hansens Method. Preliminary Results. Acta chir. scand. 97: 362, 1949.
- Kristensen, T. B.*: Ankelbrud. Nyt nordisk forlag Arnold Busck, København, 1953.
- Kristensen, T. B.*: Fractures of the Ankle. VI. Follow-up Studies. Arch. Surg. 73: 112, 1956.
- Lauge Hansen, N.*: Ankelbrud. I. Genetisk diagnose og reposition. Ejnar Munksgaard, København, 1942.
- Lauge Hansen, N.*: Fractures of the Ankle. Arch. Surg. 56: 259, 1948.
- Lauge Hansen, N.*: "Ligamentous" Ankle Fractures. Diagnosis and Treatment. Acta chir. scand. 97: 544, 1949.
- Laurent, L. E.*: Pseudarthrosis of the Internal Malleolus. Ann. Chir. Gynacc. Fenn. 45: 48, 1956.
- Lee, H. G. & Horan, T. B.*: Internal Fixation in Injuries of the Ankle. Surg. Gynec. Obstet. 76: 593, 1943.
- Magnusson, R.*: On the Late Results in Non-operated Cases of Malleolar Fractures. I. Fractures by External Rotation. Acta chir. scand. Suppl. 174, 1944. II. Fractures by Pronation. Acta chir. scand. 92: 162, 1945. III. Fractures by Supination. Acta chir. scand. 92: 259, 1945.
- Mullins, J. E. P. & Sallis, J. G.*: Recurrent sprain of the Ankle Joint with Diastasis. J. Bone Jt Surg. 40-B: 270, 1958.
- Nigst, H.*: Über Malleolarfrakturen: Pronations-dorsalflexions-Frakturen, Bedeutung des hinteren Volkmannschen Dreieckes. Pseudarthrosen des Malleolus tibialis. Mschr. Unfallheilk. 64: 351, 1961.
- Palmer, I.*: Operativ behandling av syndesmosruptur vid fotledsfrakturer. Nord. Med. 29: 349, 1946.
- Palmer, I.*: Malleolarfrakturer och deras behandling. Nord. Med. 44: 1593, 1950.
- Palmer, I.*: Nordisk Kirurgisk Förening, 30th congress, 1961.

- Proctor, H.*: Lateral Rotation Fracture-Dislocation of the Ankle. *J. Bone Jt Surg.* 36-B: 148, 1954.
- Quigley, T. B.*: Management of Ankle Injuries Sustained in Sports. *J. Amer. med. Ass.* 169: 1431, 1959.
- Rudberg, N.*: Om fibulaosteosyntes som hjälpmedel vid behandling av vissa fotledsfrakturer. *Nord. Med.* 49: 150, 1953.
- Smith, M. G. H.*: Inferior Tibio-fibular Diastasis Treated by Cross-screwing. *J. Bone Jt Surg.* 45-B: 737, 1963.
- Vasli, S.*: Operative Treatment of Ankle Fractures. *Acta chir. scand. Suppl.* 226, 1957.
- Wolff, A.*: Arthrografi av Ankelled. *Nord. Med.* 8: 2449, 1940.

#### DIVISION INTO TYPE AND SURGICAL TREATMENT OF SUPINATION OUTWARD-ROTATION INJURIES OF THE ANKLE JOINT—Series report

by *C.-A. Cedell* and *G. Wiberg* (Lund, Sweden)

In recent years ankle joint injuries have been given surgical treatment to an ever greater extent.

In the Orthopaedic Clinic in Lund we began in 1958 to operate on the oblique, distal fibula fracture and have since devoted special interest to the supination outward-rotation injuries in their 4 different stages. At the Clinic during the years 1958-1963 504 ankle joint injuries were operated on, 320 of which arose owing to a supination outward-rotation trauma (63.5 per cent). Injuries of the 1st, 2nd, 3rd and 4th degrees comprise respectively 1.2, 32.5, 6.3 and 60.0 per cent of the series, which consists of 130 men and 190 women.

A special surgical procedure was gradually evolved and we can use this with small modifications for other types of ankle joint injuries also. In *SO-injury 1st degree*, referring to a rupture of the anterior tibiofibular ligament, we operate with ligament suture and metal staple, which is fixed in the tibia and fibula and follows the direction of the ligament fibres. In *SO-injury 2nd degree*, referring to a rupture of the anterior tibiofibular ligament and oblique, distal fibular fracture, we operate with cerclage, ligament suture and metal staple (*Cedell & Wiberg* 1961). *R. Magnusson* (1944) and *Cedell* (1962, unpublished material) when following-up conservatively treated cases of stage II injuries, demonstrated an arthrosis incidence of approx. 30 per cent, a figure which illustrates the importance of an exact fracture reduction. In *SO-injury 3rd degree*, in which a rupture of the posterior tibiofibular ligament or a fracture of the posterior process of the tibia occurs, the posterior tibial fragment rarely requires special operative measures. We fix a large tibial fragment by screw. In *SO-injury 4th degree*, where a rupture of the deltoid ligament or fracture of the medial malleolus arises, we fix the malleolus fragment with a Rissler or Palmer pin.

For external fixation we utilise a lower leg plaster which the patient wears for 4-6 weeks, after which weight-bearing is permitted. The primary results have been very good and the number of complications few. Even ugly dislocated ankle joint fractures generally have a very good post-operative course.

The operative treatment of ligament injuries and fractures of the ankle joint should in our opinion effectively prevent the occurrence of posttraumatic insufficiency and arthrosis conditions.

## ARTHROGRAPHY IN ACUTE ANKLE LESIONS

by *H. Glastrup* (Stege, Denmark)

The material comprises 60 patients admitted to the hospital in Stege, Denmark, with acute ankle injuries.

*Technique.*

The standard projections used for X-raying ankle joints are as follows:

- 1) anteroposterior,
- 2) lateral,
- 3) internal rotation, giving a view between the tibia and fibula.

The same projections are used for arthrography which is done after injection of 4 ml of a water-soluble, iodized contrast medium, Trijodyl 17½ per cent.

*Diagnosis.*

When the contrast medium has been injected into the joint, the folds of the joint capsule ought to present themselves rounded and uninterrupted. Minor leakage into ligaments or the peroneus tendon sheaths is of no importance.

Oozing through fractures or along the injection needle may constitute sources of error.

*Material.*

Out of 60 in-patients 32 had arthrography. Operation was performed on 21.

In 17 cases arthrography revealed rupture of the capsule. In 15 cases the capsular rupture was confirmed by operation. Two capsular ruptures were estimated as very small.

Capsular suture was done in a total of 19 cases. The most severe cases did not have arthrography. Experience has shown that in such cases the contrast medium oozes into the soft tissues in such quantities that it is impossible to obtain good films.

At operation the injuries to the capsule and ligaments were sometimes found to be more severe than expected according to the arthrographic findings.

*Case Reports.*

Five characteristic cases were reported. All showed accurate agreement between the arthrographic and operative findings.

In 3 of these cases capsular suture was performed, in one capsular suture + suture of the syndesmosis, and in one case suture of a severe rupture of the syndesmosis.

All were bandaged for 6 weeks.

Instability of the ankle joint has not developed in any case, although great demands are made on ankle stability in the two patients who had rupture of the syndesmosis.

Only one patient has complaints, which are greatly decreasing after a follow-up period of 6 months.

Finally, one case of posttraumatic complaints was described.

## OPEN OR CLOSED REDUCTION OF ANKLE JOINT INJURIES?

by *H. Heikel* (Björneborg, Finland)

With which method of treatment are better results achieved in a hospital where the injuries are treated partly by doctors without surgical training, partly by surgeons with orthopaedic qualifications and partly by surgeons with different specialist training?

The answer to this question was sought by means of a follow-up of 104 cases of ankle joint injuries which were treated in 3½ years at Björneborg General Hospital. 88 were examined clinically and radiologically, 16 merely answered a questionnaire.

56 cases were treated conservatively and 48 surgically. 18 of the latter group were given treatment according to the method adopted from the Extremity Clinic in Gothenburg, by which a metal wire loop is drawn in the frontal plane through the tibia and the fibula (or its two fragments) and so fixes the syndesmosis; various other methods were used for the remaining 30 cases.

Subjectively as far as aching, pain on movement, stiffness, function and working capacity are concerned, the results were best in "the Gothenburg group".

From objective examination the least limitation of movement was found in the Gothenburg group and the greatest amongst the other surgically treated patients (especially dorsal flexion), while abnormally increased movement very often occurred among the conservatively treated.

On X-ray examination arthrosis was very often found in the conservatively treated and least often among the cases treated according to the Gothenburg method.

However, the difference was not significant in any of the above.

On classification into the end-results "excellent", "good", "fairly good", and "poor", on the basis of subjective opinion, the degree of movement limitation, functional disturbance and arthrosis, no difference was found between the conservative and the operative-treated, but within the latter group the "Gothenburg group" showed only 1 "poor" result as against 10 such results in the remainder of the operatively treated. This difference is significant. Amongst the "excellent" and "good" results the difference between the groups was not significant however.

If one further considers that conservative treatment failed in 22 cases and was replaced by surgical treatment, and that in 3 more cases of unsuccessful conservative treatment arthrodesis was performed, then it is possible to state that "poor" treatment results occurred twice as often with conservative treatment as with surgical treatment.

## MISSED CONCOMITANT ANKLE INJURIES IN PATIENTS WITH FRACTURES OF SHAFTS OF THE LOWER LEG BONES

by *Östen Hedström* and *Rune Sundgren* (Department of Orthopaedic Surgery and Department II of Diagnostic Radiology, University of Lund)

A review, including check-examination of the primary roentgenograms, of a series of fractures of the shafts of the lower leg bones in patients in whom no ankle injury had been detected but in whom obstinate or permanent ankle symptoms had occurred in the later course often revealed evidence of concomitant fractures of the malleoli or damage to the ligaments that had escaped discovery at the primary examination. In a 10-year series of 349 fractures of the shaft bones of the lower leg in adults

treated at the Department of Orthopaedic Surgery, University Hospital, Lund, every seventh fracture was accompanied by ankle injury, which had, however, been primarily diagnosed in only half of the group. Careful clinical examination of the ankle is recommended in all cases of lower leg fractures and in the event of substantial fracture-dislocation, supplementary roentgen examination of the ankle.

#### THE SIGNIFICANCE OF THE VALGUS DEFORMITY IN FRACTURE OF THE CALCANEUS

by *Sv. Rosendahl* (Copenhagen)

Dislocated, articular fractures of the calcaneus are always forced into a valgus position because of the pronated position of the calcaneus. A varus position may result from over-correction in the reduction. This study was a follow-up on 138 cases of dislocated articular fractures which had been treated by open reduction, active exercises without weight-bearing, and arthrodesis. In 17.3 per cent the final result was poor.

In cases with a normal position of the foot 68 showed good results and none poor.

In cases with severe valgus there was 0 good result and 20 poor.

When the position of the foot was normal 24.6 per cent, all with a good result, developed osteoarthritis in the subastragalar joints, while in cases of severe valgus 69.3 per cent developed osteoarthritis.

In cases with a normal subastragalar mobility 29 were good and 2 poor.

In cases with abolished subastragalar mobility there were 8 good and 8 poor results.

Probably the valgus deformity is the cause of the poor results following calcaneus fracture and responsible for the development of osteoarthritis. Osteoarthritis in itself is not the cause of a poor result, and spontaneous arthrodesis does not guarantee freedom from pain.

Accordingly, the central therapeutic measure is correction of the valgus deformity. The best results are found after *Palmer's* open reduction, possibly supplemented by exercises without weightbearing. Treatment with a walking cast gives the poorest results, leading to secondary compression and consequently an increased valgus deformity.

#### RESULTS OF TALOCRURALARTHRODESIS AND PANTALAR ARTHRODESIS OF THE ANKLE JOINT IN POST-TRAUMATIC CONDITIONS

by *R. Kivilaakso, A. Langenskiöld* and *P. Salénus* (Helsingfors)

The series presented here covers the cases in which talocruralarthrodesis and pantalar arthrodesis of the ankle joint were carried out in the Orthopaedic Hospital of the Invalid Foundation, Helsinki from July 1956 to June 1963.

The number of patients who were treated during this period by talocruralarthrodesis and pantalar arthrodesis of the ankle joint for post-fracture conditions was 55, of whom 43 were men and 12 women.

Arthrodesis was performed by the Adams method, with sliding graft from the anterior surface of the tibia, according to *Charnley* and without internal fixation. Fixation with a long vitallium screw driven through the plantar surface of os

calcaneus and through the talus upwards into the tibial diaphysis was used in pantalar arthrodesis and talocruralarthrodesis when the subtalar joint was ankylosed.

The Adams operation was used in 22 cases and led to bony ankylosis in all.

In two of the six cases in which ankylosis was not achieved in this series the arthrodesis was performed again. In one case the renewed treatment led to bony ankylosis, but not in the other. The fact that 4 of the 6 patients did not wish to undergo a further operation seems to indicate that fibrous ankylosis in the talocrural joint does not always cause noticeable discomfort. Good results according to the patients' estimation were achieved in 27 cases, satisfactory in 23 and poor in 5. Objective examination showed the results of treatment to be good in 43 cases, satisfactory in 5 and poor in 7.

### RECONSTRUCTION OF DEFECTS IN THE WEIGHT-BEARING SURFACES OF THE FOOT

by *Lars E. Avellán* (Gothenburg, Sweden)

#### *Primary and Secondary Weight-Bearing Areas.*

Three weight-bearing surfaces may be discerned in the foot, *i.e.*, the sole, the heel and the achilles region. These surfaces have a special skin structure in common; the skin lacks hair follicles and sebaceous glands, its epidermis is thicker, the connective tissue is more compact and therefore less elastic, the number of pigment cells is less than elsewhere and the papillae of the cutis are arranged in double rows which are covered by simple epidermis layers. The largest of the weight-bearing surfaces mentioned is the sole of the foot. As a result of my investigations I have determined that it is possible to distinguish between two areas in the normal sole, which I have called the primary and the secondary weight-bearing areas (Fig. 1). The primary surface which is exposed to direct pressure from the weight of the body, comprises the skin of the heel and of the lateral edge of the foot and also the skin in front of

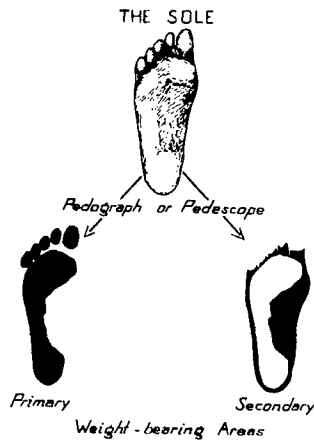


Fig. 1.

the heads of the metatarsal bones. The secondary surface is formed chiefly by the long arch of the foot. With the aid of the pedograph or pedoscope these surfaces can be marked off from each other. The pedograph is a pressure pad by means of which a foot impression is obtained on paper, called a pedogram, when the patient steps onto the pad. The pedoscope, which was constructed by *R. Bachmann* (1961) is a chair for orthopaedic examination in which the foot rests on a glass plate. With the aid of a mirror it is possible to follow the sole under various degrees of weight-bearing and in various lighting conditions and also record this on film. In my investigations I only had access to the pedograph, which gave satisfactory information about the primary weight-bearing surface.

#### *Reconstruction of Defects.*

Is it necessary to analyse the foot sole before a defect in it is reconstructed? In the examination which I made of patients with defects in the primary weight-bearing surface which were reconstructed according to conventional methods, *i.e.*, by direct suturing, by split skin grafting, by full thickness skin grafting from hair-bearing areas, by local or distant flaps or tubes, crossleg, I found in all 20 cases hyperkeratosis in the zone bordering on the intact skin. In the ten cases in which the reconstructed area lay within the secondary weight-bearing surface, hyperkeratosis was entirely absent. Microscopic examination of the border zone verified the clinical findings. Defects in the skin of the heel and the achilles region, reconstructed according to the above methods, also revealed hyperkeratosis. If a defect is reconstructed within the primary weight-bearing surface by means of a skin graft, taken from a hair-bearing area, and if this skin graft is exposed to normal weight-bearing, then the pigmentation increases, the horny layer becomes thicker and the hair follicles are keratinised. The latter are therefore easily infected and the result is an ulceration which heals poorly with a consequent distressing sore. In order to avoid these complications, defects in the weight-bearing surfaces of the foot were reconstructed in Department of Plastic Surgery, Sahlgrenska sjukhuset, with full thickness skin graft from the non-hair-bearing area of the dorsum of the foot (*Avellán & Johanson* 1963). This site was covered with a split skin graft from a hair-bearing area on the lateral side of the thigh. In special cases with acute injury, necrosis or chronic ulceration, a preparatory operation was necessary. Here a tem-

TABLE 1  
*Cause and Distribution.*

	Sole	Heel	Achilles	Total
Laceration	2	2	—	4
Pressure (plaster of Paris)	—	1	3	4
Burn	—	—	1	1
Clavus	12	—	—	12
Innocent Tumor	4	1	—	5
Malignant Tumor	3	1	—	4
<b>Total</b>	<b>21</b>	<b>5</b>	<b>4</b>	<b>30</b>

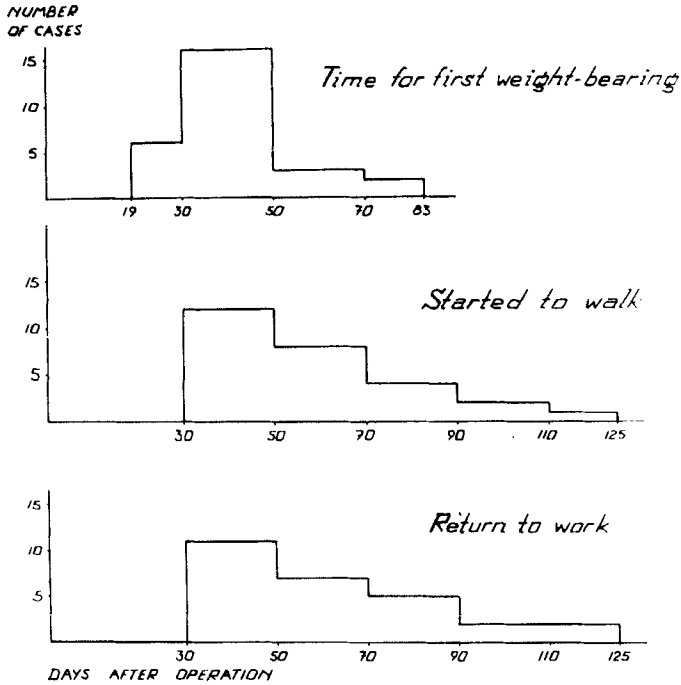


TABLE 2

porary reconstruction of the defect was performed using a split skin graft from a hair-bearing area. The series comprises 30 cases in all, 20 of which are men and 10 women. The average age was 31, the youngest patient was 16, the oldest was 66 years. The distribution of diagnosis and localisation is shown in Table 1. In 11 cases with lesser defects the full thickness skin graft was taken from the dorsal aspects of the same foot and in the remaining 19 cases from the contralateral dorsum of the foot. Treatment at the hospital lasted on average 15 days, calculated from the operation to discharge, the longest period was 30 days, the shortest was 8 days. In 28 of the cases the full thickness skin graft healed primarily. In two cases the reconstruction led to no result. In one of these cases the patient had a malignant melanoma in the sole of the foot, in which a more radical intervention was indicated, and in the other case the patient had a pressure sore in the achilles region, where a preparatory operation had been necessary. The times at which the patients began to put weight on the foot, to walk and to resume work are shown in Table 2. The longest period of convalescence, 125 days, occurred in a case with clavus in both soles of the foot, where the operation was bilateral.

### Results.

The clinical follow-up was completed with a pedogram. The pedogram gave information about how large a portion of the skin graft lay within the primary weight-bearing surface. Out of 21 foot sole reconstruction 14 lay 100 per cent within this

area 5 lay 40 per cent and 2 lay 14 per cent within it. The full thickness skin grafts of the 28 cases healed well and the scars were soft and fine. No hyperkeratosis was encountered in the zone bordering on the intact skin. The pigmentation was the same as in the surrounding skin. On the other hand the split skin graft on the dorsal foot displayed increased pigmentation. Sensibility was examined by discrimination between two points and on average the value 22.6 mm was obtained in the full thickness skin graft as against 18.5 mm in the corresponding area on the other foot. The longest period of observation was 4½ years, the shortest 2½ months or on average 2 years.

In conclusion it may be said that full thickness skin graft from the dorsal foot is satisfactory both as to function and appearance when defects in the weight-bearing surfaces of the foot and especially in the primary surface of the sole are reconstructed. Preoperative analysis of the sole of the foot by pedograph is recommended.

#### References.

- Bachmann, R.*: Über einen orthopädischen Fussuntersuchungsstuhl (Pedoskop). Zeitschrift für Orthopädie und ihre Grenzgebiete 95: 255-262, 1961.  
*Avellán, L. & Johanson, B.*: Full thickness skin graft from the dorsum of the foot to its weight-bearing areas. Acta Chirurgica Scandinavica 126: 497-504, 1963.

#### DISCUSSION:

##### *Johs. Mortens* (Copenhagen)

Congratulations to Doctor Avellán for his very valuable information concerning free skin grafting from the dorsum of the foot to the planta, which never gives rise to hyperkeratosis in the suture lines.

Doctor Avellán's well-known colleague from the Mount Vernon Hospital outside London, Doctor *Mowlem*, has shown Doctor Mortens a procedure which Mortens has used with success several times:

After excision of a hyperkeratosis area on the primary weight-bearing area of the forefoot, often in the region of the second or third metatarsal head, a local flap from the secondary area distal in the planta at the base of the toes was rotated 90 degrees and advanced to cover the excised area. The donor defect could be directly closed by interrupted sutures as the thin skin in this secondary area is very mobile. Doctor *Mowlem* has used this procedure often, and Doctor Mortens has never had hyperkeratosis occurring at the suture lines around these advancement flaps.

##### *Henrik V. A. Heikel* (Björneborg, Finland)

I have had an opportunity of testing the method reported by *Avellán* for a combined crushing and avulsion injury on a foot, where an avulsed patch of skin and subcutis, comprising the area beneath capituli II-V, half the lateral edge of the foot and part of the heel planta, became necrosed and left a large skin defect. In two sessions the defect was covered with skin first from the dorsum of one foot and then from the other dorsum. The donor sites were covered with strips of epidermis from the thigh. The patient has now walked for 4 months and has worked as tractor driver for 2 months and the transplants have remained intact.

## TRIPLE ARTHRODESIS AS A TREATMENT FOR POST-TRAUMATIC CONDITIONS

by *R. Kivilaakso* and *P. Salenius* (Helsingfors)

The material includes all patients who from July 1956 to June 1963 were treated by triple arthrodesis for post-traumatic conditions at the Orthopaedic Hospital of the Invalid Foundation, Helsinki. This made a total of 32 patients, of whom 24 were men and 8 women. The youngest patient was aged 15 and the oldest 62. The dominant indication for the operation was pain caused either by arthrosis in the subtalar joint or, in young patients, by displacement or deformity in itself.

Arthrodesis was performed by removing articular cartilage from the talo-calcaneal, talo-navicular and calcaneo-cuboidal joints, after which the bone surfaces were pressed together.

The time of immobilization in plaster was in all cases 4 months. During the first month no weight bearing was allowed but during the following three months full weight bearing was ordered in a walking plaster.

Re-examination was carried out at the beginning of 1964. In one case the Chopart joint remained unossified and the patient complained of pain. In all other cases ossification was complete. In 26 cases the result was good both subjectively and objectively.

All 26 in whom the results of treatment were good in every respect continued after re-examination the work they had been doing before the operation. Of the 6 in whom weight bearing caused pain 5 also returned to their former work.

## RESULTS AFTER AMPUTATIONS OF CHOPART, PIROGOFF AND SYME

by *Castor Lindqvist* and *Erik B. Riska* (Helsingfors)

Foot amputations are seldom taken into consideration in cases of foot injury. Perhaps below knee amputation is far too often preferred to surgery at the ankle level, or they are treated conservatively in order to preserve as much as possible. Recent development in biophysics and prosthetics, however, have stimulated interest in stumps of Chopart, Pirogoff and Syme.

Since 1960 25 patients were fitted with prostheses of plastic laminate by the Proesthetic Shop of the Orthopaedic Hospital of the Invalid Foundation in Helsinki. 19 patients were available for follow-up examination in the spring of 1964: 5 cases of Chopart, 4 cases of Pirogoff (or Boyd) and 10 cases of Syme. The number of stumps was 21 because of two double amputees.

Attention was primarily paid to the condition of the stump. Results are sum-

TABLE 1  
*Results of Surgery.*

Amputation stump	Syme No. of cases	Pirogoff or Boyd No. of cases	Chopart No. of cases
Good	8	4	3
Fair	2		1
Poor	1		2
Total	11	4	6

marized in Table 1. Secondly the function of prosthesis was investigated. Functional results are given in Table 2.

TABLE 2  
*Functional Results.*

Function of stump and prosthesis	Syme No. of cases	Pirogoff or Boyd No. of cases	Chopart No. of cases
Good	9	4	2
Fair	2		1
Poor			3
Total	11	4	6

### *Conclusions.*

1. Amputation of Syme generally results in a reliable stump which is nowadays easy to fit with a functional prosthesis.
2. Amputation of Pirogoff (or Boyd) seems to result in a stump comparable with that of Syme. Deficient ossification between os calcis and tibia, however, is a potential risk, even if it was not the case in any of the stumps examined.
3. Amputation of Chopart easily results in stumps with a great variety of discomfort, and it is problematic to fit them with a prosthesis.

## FREE PAPERS

### RESULTS OF SURGERY ON PSEUDARTHROSES IN THE LONG BONES

by *Sv. Rosendahl* and *K. Bødsgård Sørensen* (Copenhagen)

The results of 120 operations on 96 pseudarthroses done in the Orthopaedic Hospital, Copenhagen, during the period 1952-1962 were reported.

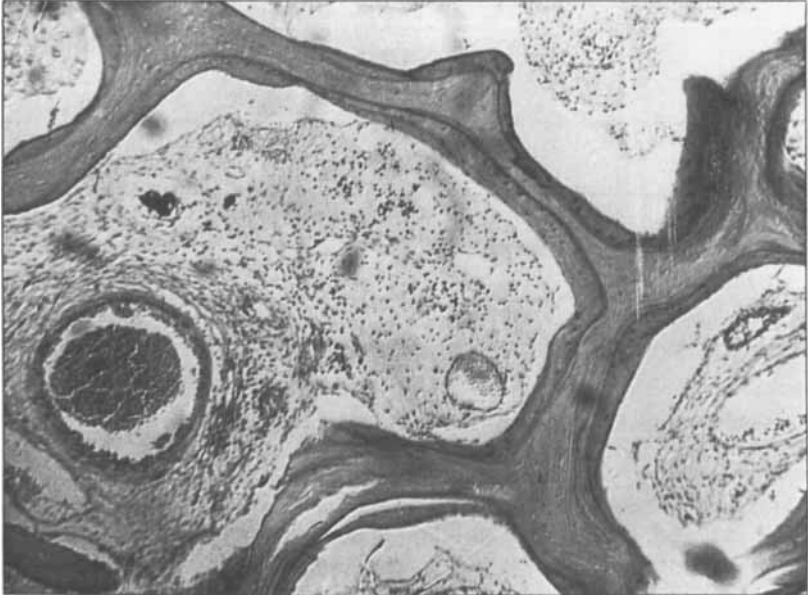
The site was the humerus in 12 cases, the radius in 10, the ulna in 14, the femur in 19, and the lower leg in 41. Healing after the first operation was obtained in 69.8 per cent. A total of 88.5 per cent had healed in 4-24 months, average 7 months. There was no difference in the healing rate by site. Out of the 11-non-healed cases 4 later had amputation because of infection and 7 were fitted with bandages after having refused to have re-operation. Two-thirds of the fractures were sustained in traffic accidents, and two-thirds had been treated primarily by osteosynthesis. There was no difference in the healing rate in the different age groups, but the healing tendency was best in the cases where pseudarthrosis was of shortest duration. Nevertheless, healing occurred in 62 per cent of the cases of more than 2 years' duration.

After treatment with grafts of cortical bone 65.6 per cent—79 per cent healed with the on-lay and 56 per cent with the in-lay technique.

After treatment with grafts of spongy bone 78 per cent—90 per cent healed with the onlay and 70 per cent with the in-lay technique.

Of the cases treated with internal fixation or with resection of the pseudarthrosis 63 per cent healed.

In other words, the highest healing rate was found after on-lay grafts of spongy bone. Resection of the pseudarthrosis and internal fixation did not improve the healing tendency.



*Fig. 1.*

**NECROSIS OF THE FEMORAL HEAD AFTER FRACTURE OF THE NECK  
OF THE FEMUR**

by *H. Bohr and E. Hjalmar Larsen* (Publ. in the British Volume of the Journal of Bone and Joint Surgery)

The sclerosis of the head of the femur which may be seen on the radiograph following fractures of femoral neck is generally interpreted as a sign of necrosis. In certain cases it is merely a question of relative increased density compared with osteoporosis of the surrounding bones, but in cases having absolute sclerosis with increased density of the bone it was previously believed that the necrotic bone had taken up further calcium as does necrotic tissue in other sites. Recently, however, it has been pointed out by several authors that sclerosis may be caused by apposition of newformed bone to necrotic bony lamellae.

In order to elucidate this aspect the present authors performed microradiographic and histological studies on the femoral heads from patients admitted to the Orthopaedic Hospital, Copenhagen, for arthroplastic operations of the hip. A total of 24 specimens were studied, 7 from patients who had been operated 1-30 days and 17 from patients who had been operated 30 days—5 years after the fracture.

Determination of the degree of mineralization by quantitative microradiography revealed no significant differences, while the width of the bony lamellae was distinctly increased in cases where X-rays showed sclerosis.

The histological studies disclosed that the increase in the width of the bony lamellae was due to apposition of newformed, living bony tissue on the surface of the necrotic bony lamellae, as seen from the figure.

It is concluded that although sclerosis observed on the radiograph is a result of

necrosis, it is at the same time a definite sign that revascularization and restitution processes are taking place. In reporting the total series the authors described details of the different phases of this process.

#### OSTEOSYNTHESIS WITH RADIOLOGICAL TELEVISION IN TWO PLANES

by *S. Ahlbäck, B. Brodén and M. Felländer* (St. Göran's Hospital, Stockholm)

The method has been employed in fractures of the femoral neck and in diaphyseal fractures of the femur and tibia.

Two closed medical TV circuits have been used, one for vertical and the other for horizontal ray direction. The roentgen and intensifier tubes are independent of one another, in order that distance and centering may be freely selected. We have used a special extension table, on which we have been able to suspend the frontal image intensifier so that it follows the movements of the table, *e.g.* in the Trendelenburg position. The projections are identical with those used in conventional roentgen examinations. In lateral projection of the femoral neck, the front of the intensifier tube is inserted above the iliac crest as far as soft tissues allow. Despite the fact that we use an intensifier tube of a dimension as large as 9 inches, the surgeon's freedom of movement is not infringed upon. The lateral view is an especially difficult projection. In order to decrease the thickness of the object we use a harness, which is attached to the table on the side of the fracture, running around the uppermost part of the thigh and flattening the soft tissues over the femoral neck and caput. During extension, the harness provides an equally efficient counter-check as a perineal post and can completely replace it. We have used the smallest possible aperture combined with high clean-up grids, which is essential for the quality of the image.

An important advantage of the method is that the equipment can remain immobile during the entire operation. It contains no stages which disrupt the operation, such as cassette changes or adjustments of the position of the equipment. The possibility of simultaneous screening in two planes or instantaneous shifting from frontal to lateral view saves time and gives greater exactness. Space around the field of operation is more ample than when an arc unit is used. Furthermore, as the equipment is immobile sterility is not endangered.

The method makes continuous checking of reduction possible, and the repositioning maneuvers may be efficiently conducted. In fractures of the femoral neck, the tip, point of entrance and direction of the guide may be determined immediately. The position of the point of the nail can be selected with a tolerance of a few millimeters, which is important in cases with a small caput fragment.

In diaphyseal fractures which are fixated through intramedullary nailing the fracture need not be exposed, which should eliminate risk of infection and a possible deterioration in the healing process brought about by exposure.

The operating time, especially in fractures of the femoral neck, is considerably briefer than when the nailing is controlled through conventional radiology.

The roentgen dosage during the nailing of a femoral neck fracture is definitely below 10 milliroentgen for the surgeon and below 5 milliroentgen for other staff.

65 operations of femoral neck fractures and 10 operations of diaphyseal fractures have been performed in accordance with the technique described above.

The lecture was illustrated by a video tape recording of televised images in both planes during a nailing of a femoral neck fracture.

#### PRELIMINARY REPORT ON THE CLINICAL TESTING OF TITANIUM

by *Hans Eneus and Gudmunder Gudmundsson* (Lund, Sweden)

For 3 years Tupman's nail and plate have been used in the fixation of osteotomies. Stainless steel and titanium were employed successively and in strict alternation throughout these operations.

During the same period arthroplasties according to *Moore* were performed and in strict succession vitallium prosthesis alternated with titanium prosthesis. 50 osteotomies and 50 *Moore* plastics make up the series. We consider therefore that we possess a clear idea of the mechanical and chemical qualities of titanium when compared with current material.

On preliminary review titanium seems capable of use for hip prostheses in the same way as vitallium. Titanium can be used as osteosynthesis material but has certain disadvantages by comparison with steel. After one has become accustomed to its special qualities, one can work very well with it.

Titanium's chemistry in living tissue has not yet been elucidated. The tissue is sometimes blackened by the titanium applications. The black pigment consists of titanium, which has been shown to be present both qualitatively and quantitatively. It is not yet possible to show in what form the titanium appears in the pigment. It is extremely interesting that the titanium osteosynthesis material adheres the tissue and that in spite of abundant manifestation in both phagocytic and non-phagocytic form it does not cause any tissue reaction.

#### THE GAIT WITH AN ANKYLOSED HIP

by *M. Foss Hauge* (Oslo)

A short survey is given of the movements of the pelvis in patients with a unilateral ankylosed hip.

The most "normal" gait—and at the same time the most satisfactory, from an aesthetic point of view—is achieved by the following position of the hip:

- 15 degrees\* of flexion.
- 3– 5 degrees\* of adduction.
- 5–10 degrees\* of external rotation.

#### REHABILITATION OF THE AGED AFTER AMPUTATION

by *Ralf Lindholm* (Vasa, Finland)

The development in geriatric care demands increased effort to satisfy, among other things, the special requirements of rehabilitation which arise in connexion with amputation surgery.

The majority of rehabilitation centres present statistical samples which obviously

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\* The degrees refer to the method of measuring joint motion, recently advocated by the American Academy of Orthopaedic Surgeons.



*Fig. 1.*

represent a selected group. The attitude towards prognosis shows a high degree of variation. The most optimistic centres completely neglect the quota of primary patients assigned to long-term care beyond the reach of rehabilitation facilities. It is therefore not possible to obtain a complete picture of the situation. This series includes 86 patients above 65 years of age who underwent amputation in a geriatric unit (Koskela/Forsby Geriatric Hospital, Helsinki/Helsingfors) with departments of internal medicine, surgery and psychiatry and with related departments of rehabilitation and physiotherapy. The series comprise all 1961-63 patients in the institution as lower extremity amputees registered; the majority underwent the operative stage at the same hospital. The amputation indication was almost without exception peripheral vascular gangrene.

Within six months after the operation 30.5 per cent of all those amputated had died. An observation which seems to give cause for considerable scepticism and reserve when evaluating the post-operative prognosis.

At the follow-up 15.1 per cent of the patients were walking; 26.7 per cent were confined to a wheel chair with satisfactory activities of daily living; 11.6 per cent were bedridden and 41.5 per cent had passed away. The last figure merely indicates a minimum mortality with 2½ years after operation. In many cases the observation period was much shorter.

The prognosis is clear in relation to the level of amputation (Table 1) and to the age (Table 2).

The principle of using a temporary prosthesis during training and as a test method seems to justify its purpose. Experience with this series confirms that the amputees accept the test method.

8.1 per cent of the amputees were found to be independent of institutional care and did not require aid socially.

The ability to walk learnt when young seems to remain throughout life, while even those in old age amputated patients who are somatically well equipped are not always able to adjust themselves to the new biomechanical situation of walking with a prosthesis.

Prosthesis training of geriatric amputees is if anything a team exercise and demands considerable institutional resources and expertise in orthopaedics, physiotherapy, occupational therapy, prosthesis maintenance and social care.

TABLE 1  
*Type of Amputation and Result of Rehabilitation in 46 Surviving Geriatric Amputated Patients.*

Type	No. of patients			Total
	Walking	In wheelchair	In bed	
unilateral thigh	5	14	7	26
unilateral lower leg	8	1	1	10
bilateral thigh	—	6	2	8
bilateral thigh + lower leg	—	2	—	2
	13	23	10	46

TABLE 2  
*Age and Rehabilitation Result.*

Age year	No. of patients				Total
	Walking	In wheelchair	In bed	Dead within 2½ yrs	
65—69	7	8	1	4	20
70—79	4	10	4	16	34
80—89	2	5	5	18	30
90—	—	—	—	2	2
over 65	13	23	10	40	86

#### OXYTETRACYCLINELABELLING OF BONE IN EXPERIMENTAL AFFECTIONS OF THE HIP JOINT

by *P. Rokkanen, P. Slätis and H. Laine* (Helsingfors)

The value of tetracycline labelling of bone has been estimated by comparison with histologic and roentgenologic findings in experiments on the hip joint. In 39 rabbits the following operations were carried out: In 15 animals the left hip joint was opened, the femoral head exarticulated and the lig. teres severed. In addition to this, the femoral neck was tightly ligated in all animals. In another 24 animals a sub-capital total osteotomy of the femoral neck was performed, in 12 without severance

of the lig. teres. The right hip served as a control. Oxytetracycline was administered on three consecutive days prior to death. The time interval between operation and death varied from 1 week to 22 months.

Oxytetracycline fluorescence in the femoral head and neck, as observed macroscopically or in the UV microscope, was compared with the histologic and roentgenologic findings. Special interest was focused on aseptic necrosis and regenerative phenomena. Histologically dead areas showed no fluorescence, whereas regenerative invasion of connective tissue and new bone was accompanied by intensive, patchy fluorescence. The fluorescence phenomenon was easily recognized and the labelled tissues well defined. The viability of the cancellous bone seemed to be more accurately revealed by the fluorescence technique than by ordinary histologic methods.

To be published in *Acta Orthopaedica Scandinavica*.

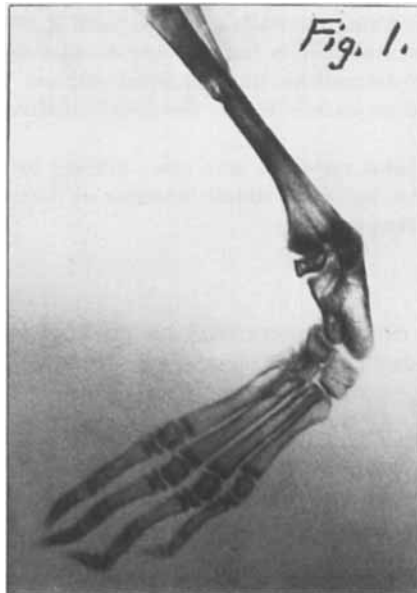
#### EXPERIMENTAL FOOT DEFORMITIES

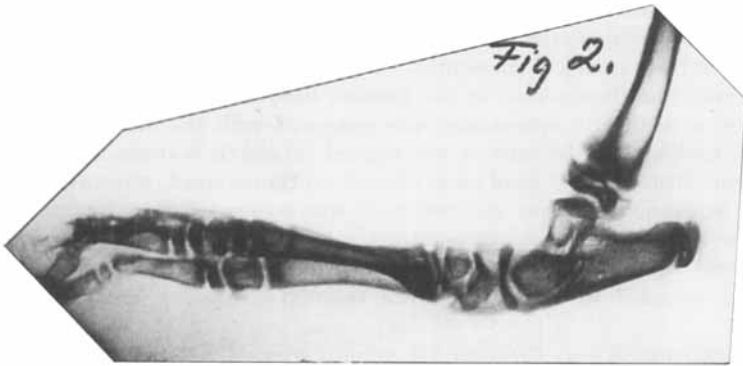
by *Veijo Ritsilä* (Helsingfors)

In order to provoke phenotypically deformities resembling congenital foot deformities various operations were performed on the leg muscles and ligaments of young rabbits. Immobilizations in plaster were also performed.

Results were based on experiments performed on about 400 young rabbits. Some dozens of combined operations on muscles and tendons were performed. Many phenocopies of foot deformities occurring in human beings were successfully provoked.

The most interesting results were obtained in pes equinovarus and talus verticalis deformities, whose changes both anatomically and radiologically corresponded fully with the changes encountered in clinical material.





Pes equinovarus deformity (Fig. 1) was achieved only in the following combination of 3 components.

First, the proximal part of the Achilles tendon was fixed through a hole bored halfway through the tibia diaphysis. Tenodesis was thus performed.

Second, dissection of peroneal muscles and musculus extensor digitorum longus was performed. Pronation effect was thus eliminated.

Third, musculus tibialis anterior, musculus tibialis posterior and musculus flexor digitorum longus and therefore supination effect were left intact.

In addition by immobilizing the foot in plaster in the equinovarus and adductus position, a permanent club-foot was obtained with an immobilization time of 3-4 weeks.

A deformity corresponding to congenital talus verticalis (Fig. 2) was obtained by performing dissection of ligamentum transversum cruris and the Achilles tendon fixation described above. Talus verticalis also developed if either musculus extensor digitorum longus or musculus tibialis anterior was dissected simultaneously with the previous operation. The deformities thus obtained differed from each other with regard to supination and pronation. It was possible to differentiate both types also in clinical material.

In later experiments talus verticalis was also obtained by provoking in another way contractures in either musculus tibialis anterior or musculus digitorum longus and simultaneously in triceps surae.

#### ON THE CLOSED AND OPEN CORRECTION OF CONGENITAL CONVEX PES VALGUS WITH A VERTICAL ASTRAGALUS

by H. Støren (Oslo)

In the title of this paper the author had added "with vertical astragalus" to the American designation "congenital convex pes valgus", because without this addition the term is misleading. The fact is that a congenital convex pes valgus may also exist *without* a vertical astragalus and it may be of the same appearance and show the same degree of contracture.

An extremely important difference between these two conditions is that in con-



Fig. 1.

genital convex pes valgus *with* vertical astragalus there is a dorsal dislocation or subluxation in Chopart's joint in which abnormal dorsal flexion occurs, so that clinically the appearance is as in congenital pes *calcaneo*-valgus. X-rays are required to make the differential diagnosis—which may be made already at birth.

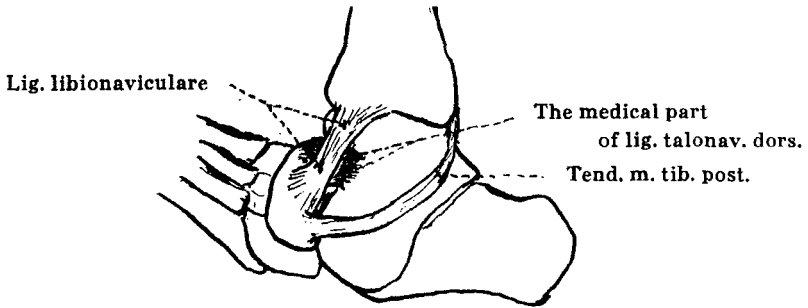
Fig. 1 shows the X-ray appearances in a 4-day-old baby with vertical astragalus. In 1934 *Hohman* gave a detailed description of this abnormality which he called "der angeborne Knickplattfuss". He reported good results of closed correction, when it was started within the first weeks of life. He applied a plaster cast until the infants started walking. But closed correction is not always successful, even when started at an early age, as is apparent from *Günz's* (1939) autopsy finding in a still-born infant. Merely the cutting of the extensor tendons and ligaments effected the reduction in this case.

At the Scandinavian Orthopaedic Congress in Copenhagen in 1962 *Wainwright* submitted good results in 8 cases treated by closed correction.

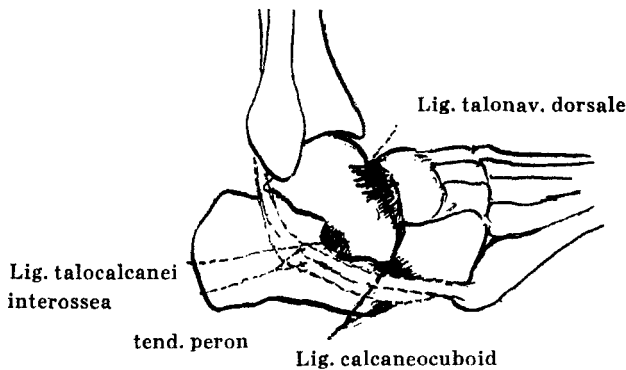
On the other hand, there are American orthopaedic surgeons, *e.g.* *Herndon* and *Heyman*, who claim that radiologically demonstrable correction can be obtained only by open reduction.

*Grice* claims that it is only in very mild cases that real cure is obtainable by closed correction, and that open reduction is needed. They all claim that any case has to be operated upon as soon as it has been diagnosed, before irreversible changes have developed.

*German* as well as American orthopaedic surgeons have pointed out that "congenital convex valgus with vertical astragalus" cannot be considered on an equal footing with secondary vertical position of the astragalus which may be seen in



*Fig. 2 A.*  
The medial side



*Fig. 2 B.*  
The lateral side

severe degrees of acquired flatfoot or in paralytic flatfoot (poliomyelitis, spina bifida, etc.).

The main difference is that these cases, unlike the congenital ones, do not develop complete dislocation or subluxation of Chopart's joint (*Grice, Herndon*).

When the treatment is started, it must be realized that it is the dislocation of Chopart's joint which has to be reduced first. The criterion of a complete reduction is that the scaphoid bone has been brought into a position correct in relation to the head of the astragalus.

In the course of the operations I found that the reduction is prevented mainly by the ligaments, less by the tight extensor tendons—and least by the peroneus tendons.

The ligaments in question are (Figs. 2 a and b):

- 1) Ligamentum tibionaviculare. (This has been described as an anomaly, but is a normal direct connection between the tibia and the os naviculare).
- 2) Ligamentum talonavicular dorsale. (The dorsolateral part is strongest, but the medial part should not be overlooked. These ligaments are found to be hypertrophic).

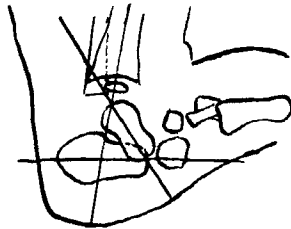
- 3) Ligamentum talocalcaneare interosseum. This ligament counteracts the reduction of the laterally displaced calcaneus and its valgus position.
- 4) Ligamentum calcaneocuboid counteracts the reduction of the abducted position of Chopart's joint. (Often it is not necessary to cut this ligament).

When these ligaments have been cut—or in closed correction sufficiently stretched—the reduction is successful. Obviously, this stretching is the more effective the shorter the period after birth it is carried out.

What influence does reduction of the dorsal dislocation of the forefoot exert upon the vertical position of the astragalus?

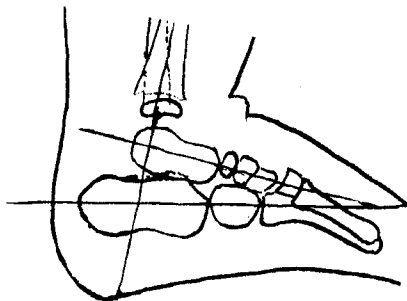
It has been found that in a lot of cases the astragalus assumes its correct position when the dislocation has been abolished. It would seem as if the vertical position of the astragalus were secondary—as it is the dorsally dislocated forefoot which presses the astragalus down into the vertical position. Fig. 3 a illustrates a Rockybottom-foot with vertical astragalus. It was reduced by the closed technique and had remained reduced for more than one year (cf. Fig. 3 b which shows the normal horizontal position of the astragalus). Then, an acute re-dislocation occurred after an incautious passive dorsal flexion of the forefoot (Fig. 3 c). Note how the astragalus, from the horizontal position, has risen into the vertical position.

In my series the cases in which the astragalus has not assumed its correct position were elderly patients who, apart from shrinkage of tibio-astragalar posterior ligaments as in inveterated cases of pes equinovarus, may be imagined to have developed secondary narrowing of the anterior part of the ankle joint.



*Fig. 3 A.*

Anne G. H. Before reduction at 3½ months of age.



*Fig. 3 B.*

Anne G. H. One year after closed reduction. Maximal dorsiflexion.  
The tibia-talus angle is normal.

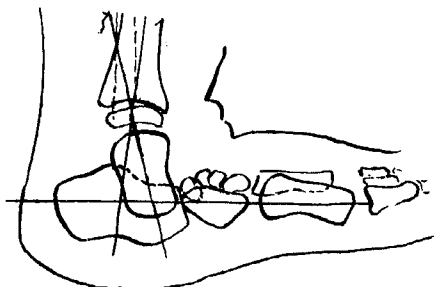


Fig. 3 C.

Anne G. H. One year later, after redislocation, the talus is pressed downwards in a vertical position.

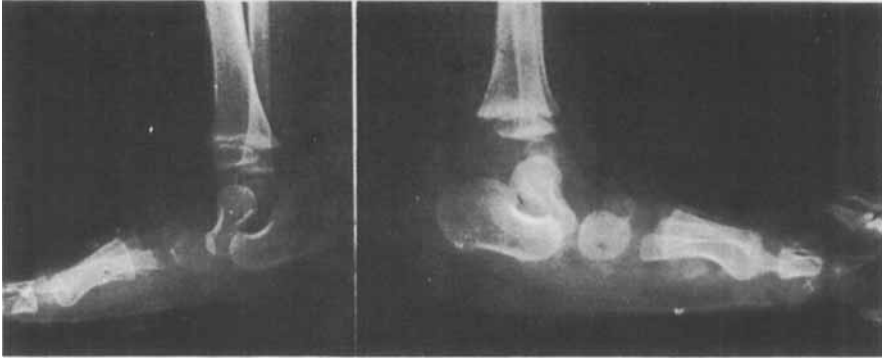
Lengthening of the Achilles tendon, in cases which I have had occasion to assess critically, appears to have had little or no effect upon the correction of the astragalus. Such lengthening has not been necessary in my cases—neither in those treated by open nor by closed reduction.

In one case, in which I believed that it was necessitated by the equinus position of the calcaneus—I performed primary lengthening. However, it proved unnecessary, if not unfortunate.

But it is not only the correction, but a permanent retention of the obtained position which poses a problem. Operation reveals dorsal flattening of the head and neck of the astragalus, due to the pressure which the dorsally dislocated scaphoid bone has exerted upon this site. This is the more pronounced the older the child. After the reduction then, the scaphoid bone lacks sufficient support and is apt to slide upwards. This is observed during the operation as well as later.

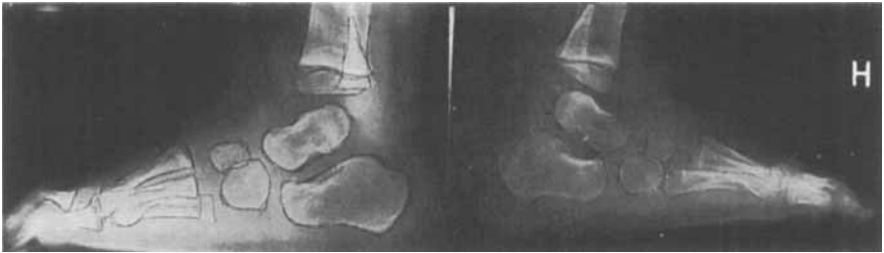
TABLE 1  
*Tabulation of Results*  
*Closed correction*

Case	Age at commencement of treatment	Age at last follow-up	Results
Moderate 3 feet	3-14 days	3-6 years	Complete cure
Severe 2 feet	4 days 6 months	3 years	(1) Complete cure (2) Acute recurrence at end of 1 year. Treatm. continued
<i>Open correction</i>			
Severe 5 feet	16 months - 5 years	8-12 years	Complete correction. Vertical position abolished



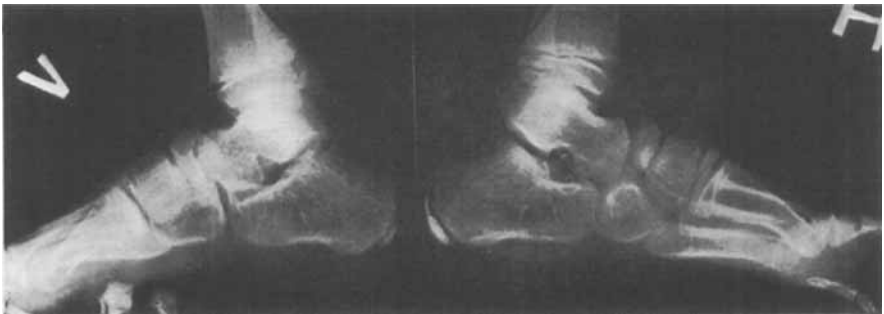
*Fig. 4 A.*

X-ray appearances before operation.



*Fig. 4 B.*

7 months after the operation.



*Fig. 5 A.*

10 years after the operation.

As mentioned by *Hohman* and *Spitzzy* the critical period occurs when the baby starts walking. When the foot leaves the floor Chopart's joint becomes dorsally flexed, with pressure beneath the forefoot. In order to prevent this action, child should wear a high-heeled shoe in which the sole is built so that the calcaneus is in a horizontal position and the forefoot in plantar flexion.



*Fig. 5 B.*

Clinical appearances 10 years after the operation. The arch of the foot is excavated, but without causing any complaint. Keen on sport. No complaints.

For lack of time I shall report here only the case with the longest follow-up, a patient who had bilateral operation at the age of 16 months and has been followed for 10 years. The Achilles tendon was not lengthened.

#### *Conclusion.*

Accordingly, the treatment of congenital convex pes valgus with vertical astragalus should be as follows:

All suspected cases should be X-rayed immediately. If the astragalus is vertical, closed correction should be performed at once. If this procedure is not successful after one or more attempts, open correction should be done. Fixation in plaster cast until weight-bearing starts. High-heeled shoe for a year or so. The patient should be X-rayed on all follow-up visits, even though the position appears to be clinically satisfactory.

## NORMAL REPAIR OF FRACTURES OF THE LONG BONES.

### A HISTO-QUANTITATIVE STUDY

by *P. Rokkanen, P. Slätis and H. Laine* (Helsingfors)

Normal repair of closed, experimental fractures of the lower leg was investigated in 60 adult white rats by histologic and roentgenologic methods up to 6 months following the fracture. The composition of the callus tissue was quantitatively analyzed from the histologic specimens by means of the linesampling method. The area of the roentgenologically visible callus was measured by planimetry of the roentgenographs.

Deposition of new bone in the periosteal collar far away from the broken bone ends can be detected as early as 6 days after the fracture. Cartilage and connective tissue, however, quantitatively dominate the callus (53-71 per cent) during the first 4 weeks of repair. After this, the amount of new bone correspondingly increases to a maximum (62 per cent) 12 weeks after the fracture. The area of roentgenologically visible callus reaches a maximum about 8 weeks after the fracture.

To be published in *Acta Orthopaedica Scandinavica*.

## DISCUSSION:

*H. Heikel* (Björneborg, Finland)

It is surprising that such good results have been achieved in epiphysis transplantation with such old test animals of Mr. *Ryöppy* partially used. In my own experiments I thought that I found the capacity for growth in length to be less in older than in very young animals, in which the ossification of the epiphyseal nucleus was only just beginning or had not yet begun. When the transplant is inserted into a defect in a long bone which is connected at both ends (by ossification or by ligament) with another bone (such as fibula and tibia), it cannot be excluded that continued growth of the latter bone may produce a stretching of the transplant and that the observed increase in length cannot be definitely interpreted as true growth.

## ARTHRODESIS CARPI

by *P. Salenius* (Helsingfors)

At the Orthopaedic Hospital of the Invalid Foundation, Helsinki in the period 1945-1963 arthrodesis of the wrist was performed in 42 cases. Of these patients 35 were men and 7 women. The youngest patient was aged 14, the oldest 56.

The Brittain method was used in most cases, but in some the method was modified by fixing the graft with screws. Five patients were operated upon without a tibial graft.

Among those treated by the Brittain method a fracture occurred in the graft in four cases, and fibrous union in three cases. Five of these cases were re-operated with good consolidation as a result. Two patients had a fracture of the tibia from which the graft was taken.

39 of the patients were re-examined in 1963 and 1964. In 37 cases the treatment had led to bony ankylosis in the wrist. One patient had a clear pseudarthrosis in the operation area, in another patient the treatment had led to fibrous union.

Objective results were good in 26 cases, satisfactory in 11 and poor in 2.

Results on re-examination according to the patients' estimation were good in 31 cases, satisfactory in 6 and poor in 2.

COMPLICATIONS OF AND ERRONEOUS INDICATIONS FOR  
LOCAL TREATMENT WITH CORTICOSTEROIDS

by *Lis Zachariae* (Copenhagen)

Upon systemic as well as topical administration cortisone preparations inhibit the newformation of connective tissue, acting upon all components of the connective tissue. Clinically, this effect is antiinflammatory, antioedematous, antiallergic, and analgesic.

The complications of local treatment are infection and degenerative changes. A number of slides illustrated these facts. Particular importance is attached to the finding that local treatment with corticosteroids in cases of osteoarthritis may be followed by considerable, radiologically demonstrable exacerbation.

The various theories advanced concerning this exacerbation of osteoarthritis during corticosteroid therapy were mentioned, *i.e.* traumatic, spontaneous progression of the original disease or a Charcot-like mechanism, *i.e.* the joint being worn because it has been rendered painless by the treatment.

In the author's opinion none of these theories is satisfactory. It is suggested that cortisone therapy inhibits the regeneration which must always go on in the tissues, so that degenerative processes predominate.

Finally, it is pointed out that cortisone preparations should only be used in diseases in which the above-mentioned special effects are desired. For instance, local treatment with cortisone preparations should be considered contra-indicated in diseases such as osteochondritis, Schlatter's disease and the like, in which regeneration of the tissue is desired.

The following conclusions are drawn:

- 1) On local administration corticosteroids have fundamentally the same effect upon mesenchymal tissues as when administered systemically.
- 2) The corticosteroids inhibit the newformation of connective tissue; they have an antiinflammatory, antioedematous, antiallergic, analgesic, and possibly also a specific effect upon joints.
- 3) These actions may in certain cases have a therapeutic effect, while in other cases they may give rise to degeneration and necrosis of the tissues.
- 4) Locally administered cortisone preparations are to some extent absorbed in the organism, but rarely to the extent of giving rise to systemic side effects.
- 5) Infection is also an important complication.
- 6) There is an indication for therapeutic use of corticosteroid preparations only in diseases in which an antiinflammatory effect or an inhibition of connective-tissue newformation is desired.