FROM THE ORTHOPAEDIC CLINIC IN OSLO. CHIEF: EIVIND PLATOU, AND THE COAST HOSPITAL AT STAVERN. CHIEF: H. STÖREN

OPERATIVE TREATMENT OF CLUB-FOOT IN OLDER CHILDREN AND ADULTS

BY

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As social medicine is improved in the different countries, cases of severe untreated congenital club-foot in adults become more rare, and in Scandinavia they will soon presumably disappear altogether.

Therefore the clubfoot material in older children and adults will be increasingly made up of relapsed cases; these, however, will hardly show such severe deformity of the soft parts, nor such extensive bony deformity as used to be seen in untreated older cases of club-foot.

There have been a number of opinions about the treatment of clubfoot in older children and adults. On the one side were the supporters of the original bloodless instrumental reduction. This method was developed by Lorenz and his pupils, who followed it. Thus Haberler in 1929 published a case of severe clubfoot in a 28-year-old man, treated by repeated closed instrumental correction with a good result, and he asserts the advantages of bloodless correction over open operative treatment even in adults. However, the case was only followed for little over 6 months, and it is not very convincing when he quotes this very case with so short an observation time as from "unser reichen Materiale", as an example of the method's excellence.

[1] Paper read in abbreviated form at the meeting of the *Nordisk Ortopedisk Forening* in Oslo 1939. The work, of which the publication was delayed during the war, has later been supplemented.

Monberg in his big work on clubfoot in 1932 examined all the open operative methods which had been used and came to the conclusion that if a patient with severe clubfoot did not come to treatment before he was 20 years old the changes were so extensive that none of the operations he described would give a satisfactory correction. His conclusion was that the foot should be amputated in these cases.

Since my paper in 1939 Snorre Hallgrimsson has published his "Studies of reconstructive stabilising operations on the skeleton of the foot" in 1943. He showed that in the Orthopaedic Clinic in Stockholm the usual wedge-shape tarsectomy had been widely used for clubfoot in older patients, but that only $^1/_6$ of these patients showed at follow-up examination a really satisfactory result from both the functional and anatomical points of view.

From 1933 the Clinic began to supplement wedge resection with arthrodesis, with if necessary a wedge in the talo-calcaneal joint.

Hallgrimsson says that subastragalar arthrodesis was increasingly used because of its satisfactory results, and that from 1941-43 this method was used on all clubfeet which could not be corrected without open operation after the patient was full-grown.

The bone operation itself corresponds in major part with the method which I used in the same year (cf. Case 1). But the reader will see that there are important differences between the method used in the Clinic in Stockholm and mine.

Talectomy, which has for many years (Lund 1872) been used for severe clubfoot in older patients, has had many supporters. Monberg still recommended it in 1932 for some cases.

However, I have the impression that all the descriptions of the position after talectomy show not quite good correction, with severely limited movement in the ankle-joint. A further frequent sequel of talectomy is also a painful osteoarthritis in the uppermost, inadequate joint, which is formed between the malleolar cleft and the calcaneus.

In severe degrees of untreated clubfoot in adults and older children the deformity of the soft tissues, including the skin, is a bigger problem than even the bone operation. If one deals exclusively or mainly with the bony parts a wretched result is obtained, especially if the operation is carried out in one session. I saw a 36-year-old schoolteacher, with severe bilateral clubfoot, who had been treated with a wedge tarsectomy, lengthening of the Achilles tendon and subcutaneous plantar fasciotomy, all in one session. In addition to the operative removal of so much bone that only the posterior part of the tarsus and the mid-foot remained, several toes had been lost through gangrene. When I saw him he had been admitted for amputation because of pain in the remaining part of the foot. With such a result one may say that any of the methods mentioned so far could have given a better result.

Hallgrimsson's work lacks an adequate account of the degree of deformity before operation—and especially the degree of fixation. From his photographs it would appear that the cases were mild ones. This agrees with the operative treatment which appears to concentrate exclusively on the bone. The only soft-tissue operation which appears to have been used was subcutaneous fasciotomy, or subcutaneous lengthening of the tendo Achilles. In fact there is no great difference from the method used on the schoolteacher already mentioned, and I dare to say that it would have given as unsatisfactory a result in the severer degrees of clubfoot.

The first case of severe clubfoot in an adult which I operated in one session developed gangrene of the 4th and 5th toes, in spite of careful preservation of the vessels, and the smallest possible resection of the bone of the root of the foot. The usual wedge tarsectomy, open medial myofasciotomy, and lengthening of the Achilles tendon was done in one session (case 1). The other foot, which had the more severe deformity, I operated in 2 sessions, and the postoperative course was uncomplicated. Since I began to operate in 2 or 3 sessions, I have not again met gangrene of the toes, although in the preliminary soft-tissue operation, with correction of the foot

without removal of bone, the neurovascular bundle is considerably stretched, as can easily be seen during the careful soft tissue dissection, and stretching of the vessels might theoretically lead to thromboses with gangrene of the toes. I have never seen it following a gentle anatomical operation on the soft tissues, and believe that if gangrene occurs it is due either to non-anatomical operative technique or to pressure by the bandages and oedema. The last will be considerably greater after an operatin in one session.

This patient shows after 8 years a good functional result —better on the second side—due certainly to the horizontal osteotomy in the calcaneus. The cosmetic result is more a matter of subjective judgment, but in my opinion it is not creditable in this patient. The feet are short and plump with consequently disproportionately long toes (see Case 1. Fig. 4).

Actually Hallgrimsson says in his work that one must not fail to obtain a complete correction, for fear of removing too much bone. Others have said the same, and in severe clubfoot the result of this may be the same as in the school teacher. Even in less severe cases it is desirable that as little bone as possible be removed, since many clubfeet are already small, partly congenitally (as one can see in unilateral clubfoot in newborn infants) and partly due to disuse-atrophy of those parts of the foot which do not bear weight (cf. Case 5, figs 8 a and 8 c, where only a minimum wedge of 0.3 cm. had been removed).

Unilateral clubfoot especially should not be further reduced by operation since a marked difference in the size of the 2 feet not only makes the choice of shoes difficult, but also is cosmetically very unattractive, with the disproportion of the parts of the foot which is produced by big tarsectomies (cf. Case 1, Fig. 4).

A still more important objection to big tarsectomies which go into the neck of the astragalus is the danger of damaging the blood-supply and producing an aseptic necrosis of the astragalus. McKeever, Frederick Marek and others have all

drawn attention to this danger, and Watson-Jones to the danger of fracture of the astragalar neck.

The method which I shall describe here reduces the removal of bone to the minimum. The size of the foot is practically speaking not reduced, while a complete correction is obtained.

Platou introduced into Phelb's operation the use of a skin graft to cover the skin defect on the medial side. This is of considerable value. He tried first to swing a big soft tissue flap down from the ankle, but this was both more complicated and cosmetically less satisfactory.

Operative Technique.

In 1935 I completely carried out for the first time the method which I shall describe here, and which is built up on my own and others' experiences. The first patient was a 23-year-old woman with severe and completely fixed clubfeet. The result can be seen from the case history and the photographs (Case 4, Fig. 7 a, b, c, d, e).

The operation is done in 3 sessions; in some cases only 2 are used:

SESSION 1. Soft tissue operation on the medial side.
2. Lengthening of the Achilles tendon and lowering of the heel. Perhaps tendon transplantation.
3. Bone operation.

SESSION 1: Soft tissue operation on the medial side.

A medial and rather dorsal longitudinal incision, which begins below the malleolus, (fig. 1 A) is made. The deformed fascia and ligaments, the plantar aponeurosis and the posterior origin of the plantar muscles are divided, and the deep ligaments are cut through down to Chopart's joint, the navicular-cuneiform joint, and partly to the talo-calcaneal joints. The attachment of the tendon of the tibialis posterior to the

tuberosity of the navicular bone is preserved. The medial half of the attachment of the Achilles tendon is divided. All this is done with careful preservation of the vessels and nerves. In these severe degrees of clubfoot the tibialis anterior is no

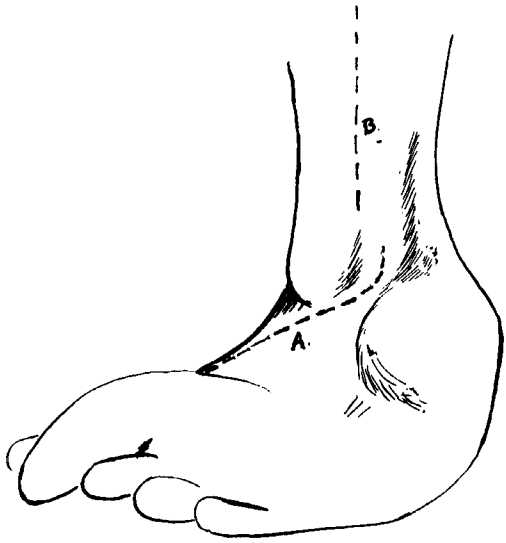

Fig. 1.
Right club-foot seen from behind.
A.: Skin incision for the medial myofasciotomy and for division of the ligaments.
B.: Skin incision for lengthening the tibialis posterior and the flexor digitorum longus.

longer a dorsiflexor, but has become almost entirely an adductor and is greatly shortened. Either its attachment is separated in preparation for later transplantation to the dorsum of the foot, or it is lengthened through the next incision.

A new longitudinal incision is now made (fig. 1 B) above and behind the medial malleolus, and through it the tibialis posterior, the flexor digitorum longus and sometimes the flexor hallucis longus are lengthened. (The last is more often lengthened through the first incision on account of the distal extens-

ion of its muscle belly.) The tibialis anterior's tendon is lengthened, as already mentioned, through this incision. The advantage of lengthening the tendons out of the plantar operation field is obvious. The foot can then be considerably corrected, but when one comes to close the wound the skin corresponding to the lower incision stands up as a tight bridge and reduces the full effect of the operation. Therefore either a dorsal flap is made or a bridge of skin parallel with the incision is pulled down. Thus the skin is closed over the operation area. Sterile dressings are applied over the wounds and the foot is plastered in the best possible position, with the knee, of course, included. A window is cut in the plaster and the skin defect is covered with Thiersch grafts. This operation enables the inflexion, the adduction and partly the varus positions to be almost completely corrected. (See Case 5, Fig. 8 b). Calluses and bursae are not removed, since they disappear spontaneously.

SESSION 2: Lengthening of the tendo Achilles.

This is done 4 weeks later. It is done before the bone operation to avoid breaking the anterior osteotomy surfaces when forcing the foot up into dorsiflexion. The tendon is lengthened by Bayer's method. The lateral attachments to the calcaneal process are preserved. The tightened soft tissues are divided and detached towards the joint. The joint capsule itself, however, is poorly developed posteriorly and offers little resistance. The changes in the relative sizes of the contacting talus and the malleolar cleft mean that some of the resistance to dorsiflexion comes from the joint itself and cannot be remedied in this operation. The heel is pulled down with Schede's apparatus with the help of a wire through the posterior part of the calcaneal process. The wire is included in the plaster. The effect is greater if one uses continuous traction which may be combined with the plaster. There is rarely more than 10-15° of the equinus position remaining as a result of the bone changes already described. The way in which this

last part of the equinus position is eliminated is described below.

Occasionally radiography after correction shows, as in Case 4, Fig. 7 f, a considerable disuse atrophy of the calcaneal processes, which affects the final result. When the equinus position is straightened the tibialis anterior, which may have been detached earlier, is transplanted to the base of the second and third metatarsals.

SESSION 3: Frontal and horizontal wedge osteotomy.

This is done 4-5 weeks later. A longitudinal incision is made just below the outer malleolus (see Fig. 2), long enough to expose the necessary parts. Originally the peroneal tendons were temporarily divided, but later this has been avoided from fear that necrosis of the skin edges might compromise the tendon sutures. The wedge is laid partly in and partly in front of Chopart's joint, and similarly in or below the talocalcaneal joint, the choice depending on the position of the convexity on the radiograph. In order to avoid the possibility of aseptic necrosis of the talus I never go far into the neck of the talus and I preserve the dorsi-medial part of the capsule and the periosteum to which it is attached—in order not to damage the vessels which run here and are important for the nutrition of the talus. (I cannot say, however, that I have ever seen an aseptic necrosis of the talus before I began to observe this rule, even when the wedge was removed extraarticularly from the anterior part of the neck of the talus behind Chopart's joint.)

Even in the most severe degrees of clubfoot the base of the wedge is not wider than 1-1½ cm. in the frontal plane, and about ¼-1 cm. in the horizontal plane of the calcaneus. The osteotomy surfaces are fixed to each other with silk or catgut. The forefoot is twisted into pronation as required. It does not seem to matter whether one does a full arthrodesis or takes the wedge outside the joint, provided the chiselling is in the right place and sufficient to obtain full or slight over

correction. The supination-pronation movements of the tarsus are lost anyway.

For the equinus position which, as already mentioned, still remains, the wedge osteotomy of the calcaneus is made broader anteriorly and the frontal wedge is correspondingly adjusted. In this way the equinus foot is remedied without producing

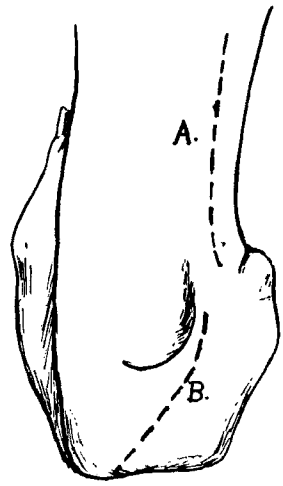

Fig. 2.
Right club-foot seen from the lateral side.
A.: Skin incision for lengthening of the Achilles tendon.
B.: Skin incision for removal of frontal and horizontal wedges from the calcaneus.

the rocking-foot so often seen when a wedge osteotomy is done without sufficiently rectifying the equinus foot.

15 cases have been operated by this method: 6 bilateral and 9 unilateral, giving, in all, 21 clubfeet. 1 case which makes an introduction to the method is described below, together with 6 bilateral and 3 unilateral cases which were operated essentially by the method.[1]

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[1]) Lack of space makes it impossible to give a complete history of every case.

Fig. 3.
Showing the compensatory valgus position at the ankle-joint with pes equinovarus in a man aged 23 years. (Case 1.)

Case Histories.

Case 1. Figs. 3 and 4.

A 23-year-old man, previously untreated.

There was a severe degree of completely fixed bilateral club-foot. Fig. 4 a shows all the different components of the faulty position of a club-foot very marked, especially on the R. side.

15.7.33. Operation on the R. foot in one session by the author.

The usual big wedge tarsectomy was done, and before closing the osteotomy surfaces myofasciotomy and tendon lengthening were carried out through a medial incision. After closure of these two operation wounds, lengthening of the Achilles tendon was done at the same session. Gangrene of the 5th and part of the 4th toe occurred in spite of careful preservation of the vessels.

6.8.43. 3 weeks later, the first of 2 operations on the L. foot: Session 1: Wedge in Chopart's joint and open medial myofasciotomy. A considerable wedge was also removed here.

1.9.43. 3 weeks later, Session 2: Horizontal calcaneal wedge and lengthening of the Achilles tendon. The postoperative course was uncomplicated in this foot.

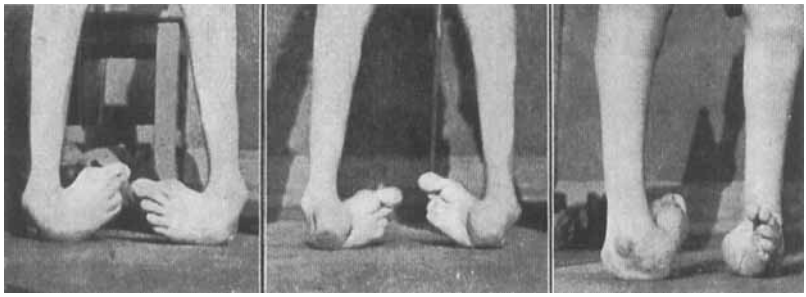


Fig. 4 a. Case 1. Severe club-foot in a man aged 23 years.

Fig. 4 b. Case 1. 6 months after operation. Good functional result, but the feet were short and clumsy.

Fig. 4 b shows the feet 6 months after operation. They are rather shortened, but the functional result is good. Slight varus of the L. heel.

6 years after the operation the patient replied to a questionnaire. Position of the feet unchanged. No pain. Slightly turns over the L. heel, not the R., and he is particularly pleased with the L. foot. There is up-and-down movement at the ankle-joint and he has obtained his certificate as a driver.

It can be seen that the L. and worst foot, which was operated in 2 sessions, had an uncomplicated postoperative course, and the result was both functionally and cosmetically better—but I consider that there is no doubt that the result would have been much better if I had used the method I adopted later and which I have described above.

Case 2. An 18-year-old boy, had not been treated earlier for congenital

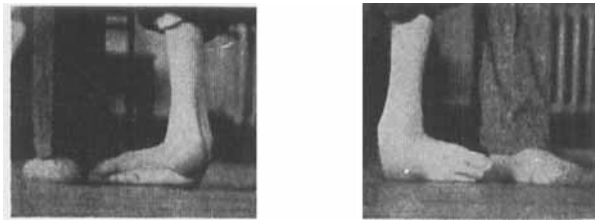


Fig. 5 a.
Before operation.

Fig. 5 b.
3 months after operation.

Fig. 5, a and b. Case 2.
Showing club-foot in a boy aged 18 years, before and 3 months after operation. The operation was done in 2 sessions as on the right foot in the preceding case. As the contracture was less severe, however, the foot showed less reduction in size and was a good shape.

equinovarus of the R. foot. He bore weight on the dorsum of the forefoot. The position was not so fixed as in the previous case.

9.3.34. Operation by the author. The same method of operation in 2 sessions as in the L. foot in the previous case. Uncomplicated post-operative course. Fig. 5 a shows the foot before operation and Fig. 5 b the same foot 3 months after operation. He has 15° dorsiflexion and 15° plantarflexion. Still slight swelling. Walks without pain and with ordinary shoes. No reply to questionnaire. (Finmark.)

Case 3. 29-year-old stonemason. Treated at the age of 18 months but not later. A milder degree of clubfoot, but firmly fixed. He bore weight exclusively on the lateral part of the foot. There was marked muscle atrophy in the calf and the foot was foreshortened. There was considerable contracture of the Achilles tendon.

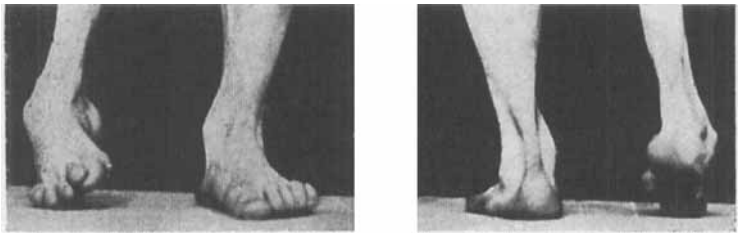


Fig. 6 a.
Before operation.

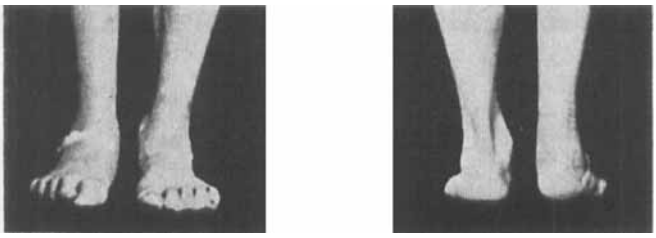


Fig. 6 b.
After operation.

Fig. 6, a and b. Case 3.
Stonemason aged 29 years, treated when 18 months old. Moderate degree of clubfoot, but rigidly fixed. When walking he puts weight exclusively on the lateral part of the metatarsus.

20.9.35. First session. The author. First, a medial soft-tissue operation, followed by an anterior wedge with a 2 cm. wide base in Chopart's joint, and about ½ cm. wide wedge in the calcaneus below the talo-calcaneo-joint.

20.10.35. Second Session. Lengthening of the Achilles tendon. The heel was drawn down with Schede's apparatus.

Both postoperative courses were uncomplicated. Discharged after 12 weeks—wearing ordinary shoes. Dorsiflexion at that time 0°. Plantar-flexion 15°.

Fig. 6 a shows the foot before operation; 6 b shows the foot after the operation.

The questionnaire was answered by his doctor 4½ years later. "No change in the position of the foot according to the patient. Walks with ordinary shoes. Has pain only if he walks a lot."

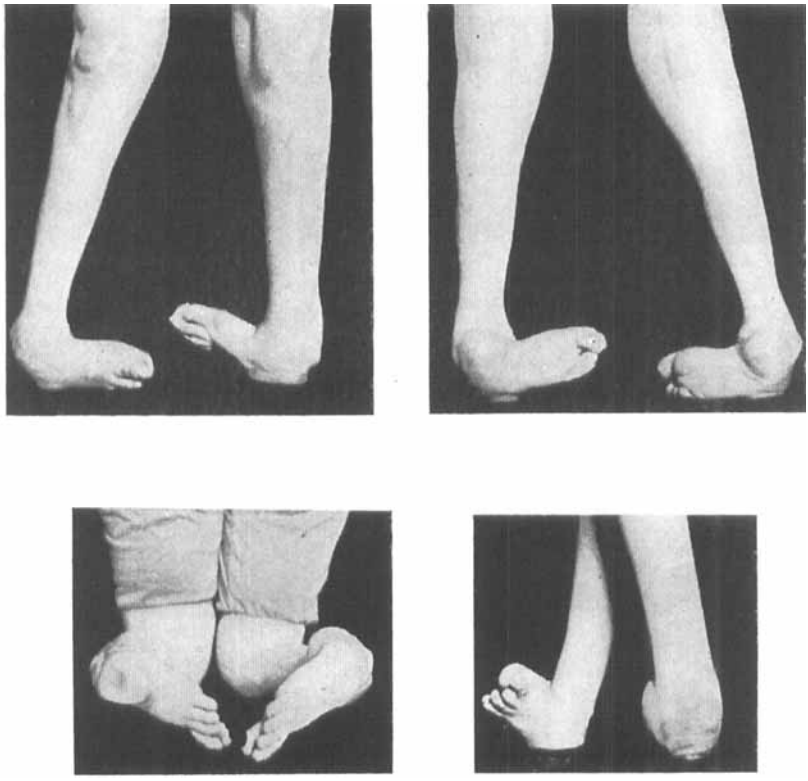


Fig. 7 a. Case 4.
Before operation.
7 a. Girl aged 23 years, with rigidly fixed clubfoot, previously untreated.

Case 4. A 23-year-old girl. Previously untreated. Severe degree of bilateral clubfoot, firmly fixed. Most marked on the L. side. (Fig. 7.) Considerable disuse atrophy of the forefoot and toes.

12.12.35. Operation by the author. Skin incision as in Figs. 1 and 2. Open medial fasciotomy of both feet. All the short plantar muscles and the plantar fascia detached at their origin, also the long plantar ligament and capsule and ligaments of the talo-navicular joint. The medial part of the Achilles tendon divided at its attachment. The tibialis posterior and the flexor digitorum longus tendons lengthened through the longitudinal incision behind the medial malleolus; also lengthening of the tibialis anterior through this incision. An almost complete correction of the adduction component of the faulty position was obtained. (Fig. 7b.)

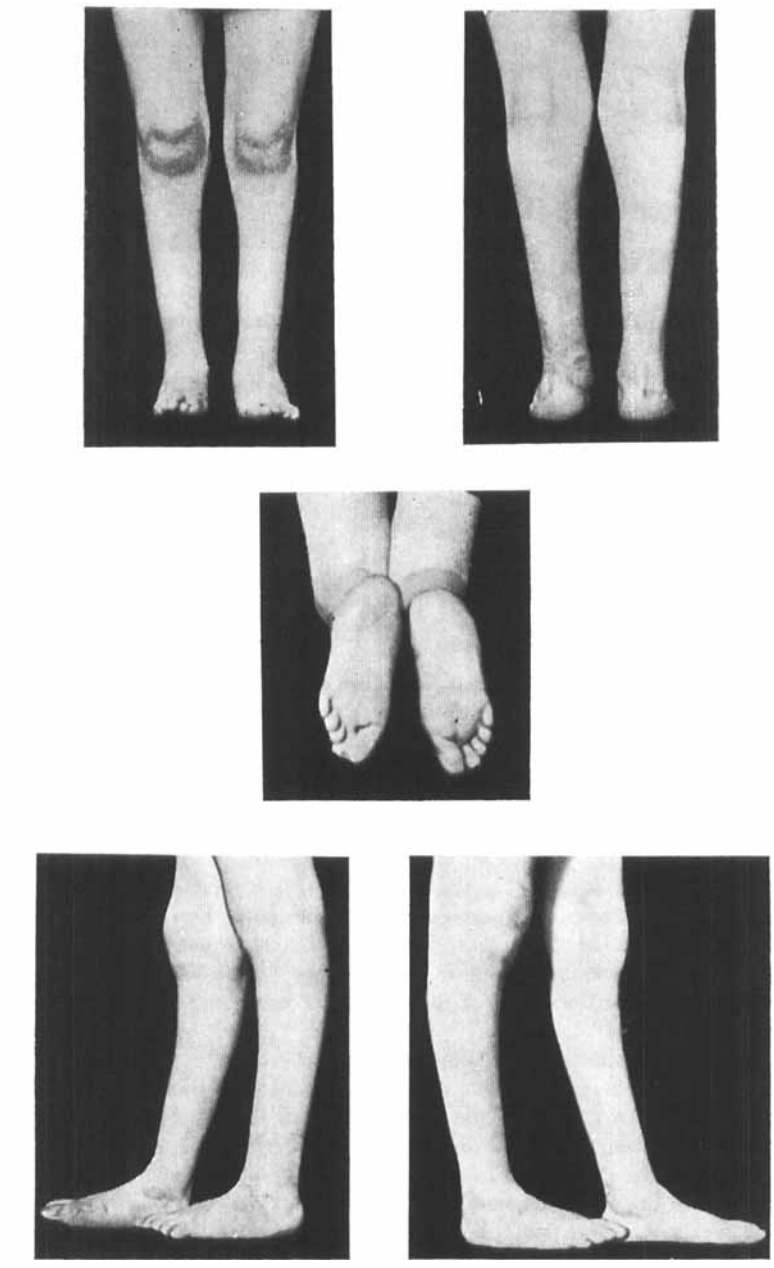


Fig. 7 b. Case 4.

The feet 1 year after operation. This is the first case in which the method adopted later was used. Note the very slight reduction in the size of the feet, in spite of the original severe and firmly fixed deformity.

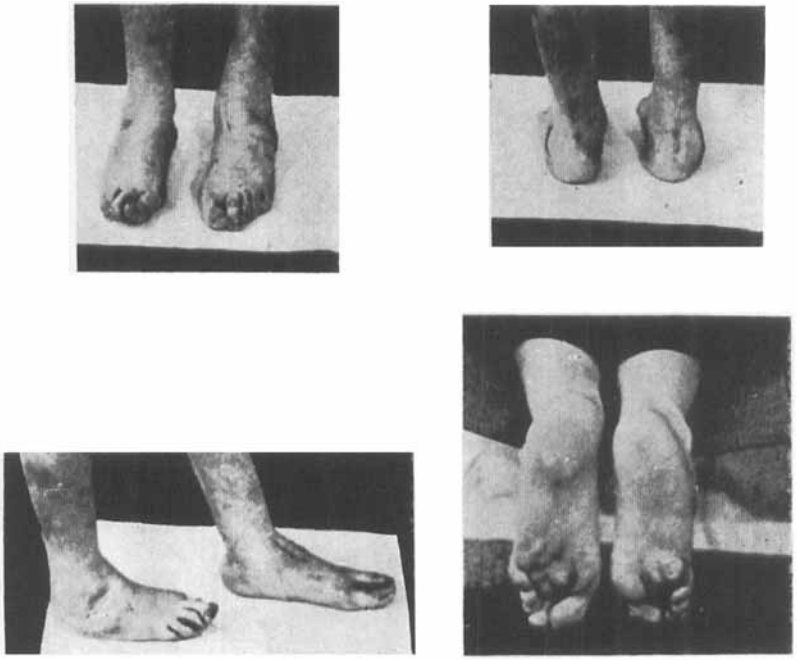


Fig. 7 c. Case 4.
The feet 6 years after operation. No further change in the condition. Callosities have formed beneath the heads of the metatarsi.

The radiograph taken after operation shows this and also the deformity of the bones of the tarsus and the marked disuse atrophy of the calcaneal process.

The skin was closed by a flap made by a skin incision parallel with the wound. The posterior part of the wound could thus be closed. The wound was dressed and plaster applied with the foot in the correct position, and through a window made in the plaster the anterior part of the wound and the defect at the donor site was covered with Thiersch grafts.

Session 2, 4 weeks later. Lengthening of the Achilles tendon on both sides. All tight tissue divided, the calcaneus process pulled down with Schede's apparatus, and the pin incorporated in the plaster.

4 weeks later. Session 3 on both feet. Anterior wedge in Chopart's joint and horizontal wedge in the talocalcaneal joint. It should be noted that even in the more deformed L. foot the base of the wedge in Chopart's joint was not over 1 cm. (½ cm. in the calcaneus). The forefoot was pronated with the closure of the anterior osteotomy. Plaster for 8 weeks.

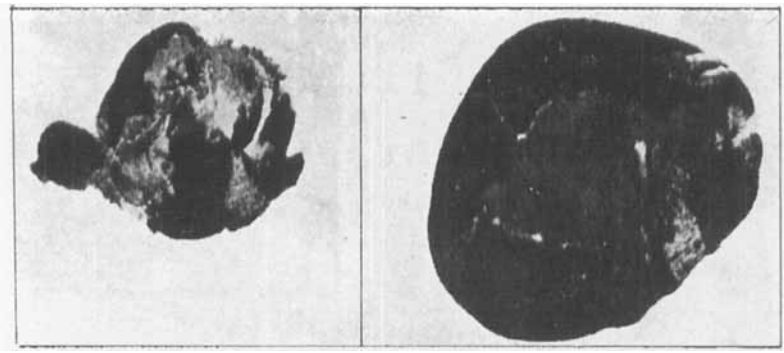


Fig. 7 d. Case 4.
Imprint of right and left feet of same patient before operation.

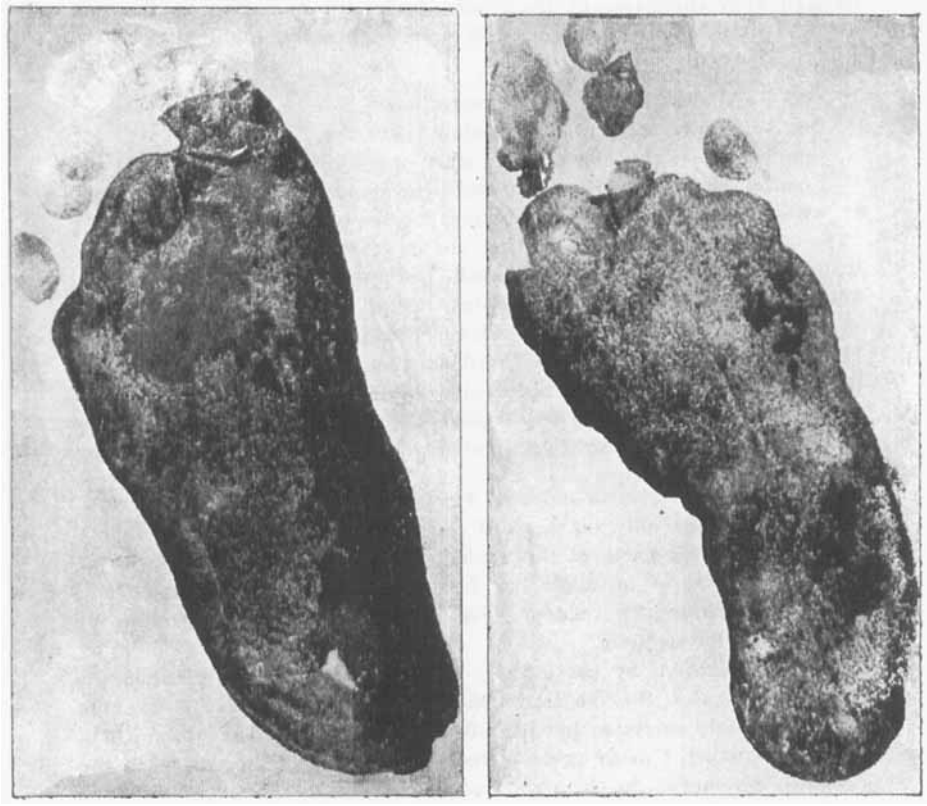


Fig. 7 e. Case 4.
Imprints of right and left feet after operation.

Fig. 7 f. Case 4.
Showing the severe disuse atrophy of the calcaneus process which may be seen after correction of the deformity by the operation on the soft tissues, in a woman aged 23 years with severe clubfoot.

Fig. 7 a shows the feet before operation.

Fig. 7 b shows the feet 1 year after operation.

Fig. 7 c shows the feet 6 years after operation.

Fig. 7 d, show imprints of the feet before and Fig. 7 e after operation.

4½ years after operation the patient replied to the questionnaire that: "The position of the foot has not changed; slight pain when she has walked at work all day, but not much. The ankle joint moves quite well. Walks with ordinary, ready-made, low-heeled shoes."

6 years after operation she wrote: The position of the foot is as before. Somewhat troubled by "hard skin" under the balls of the toes, but otherwise no pain. Does not deform her shoes. She sent photographs which show marked callosities under the head of the metatarsal, a condition which could have been corrected, but contact was lost during the war. Fig. 7 c.

Case 5. Fig. 8. 11-year-old boy. Previously untreated severe L. clubfoot. Weightbears only on a small area on the dorsum of the cuboid and the adjoining parts of the navicular and head of the talus, where a bursa the size of an apple has formed. *The forefoot is trophic and altogether considerably reduced.* (Fig. 8.) There is 2 cm. shortening of the affected lower limb.

9.1.37. Operation by the author. The same method as described for the previous cases. Fig. 8 b shows that the foot has practically speaking been completely corrected by the soft tissue operation. The prominences are bursae which I never remove since they quickly disappear when the pressure is removed. In the second session a horizontal wedge was made in the calcaneus 3-4 mm. wide at its base and an anterior wedge in

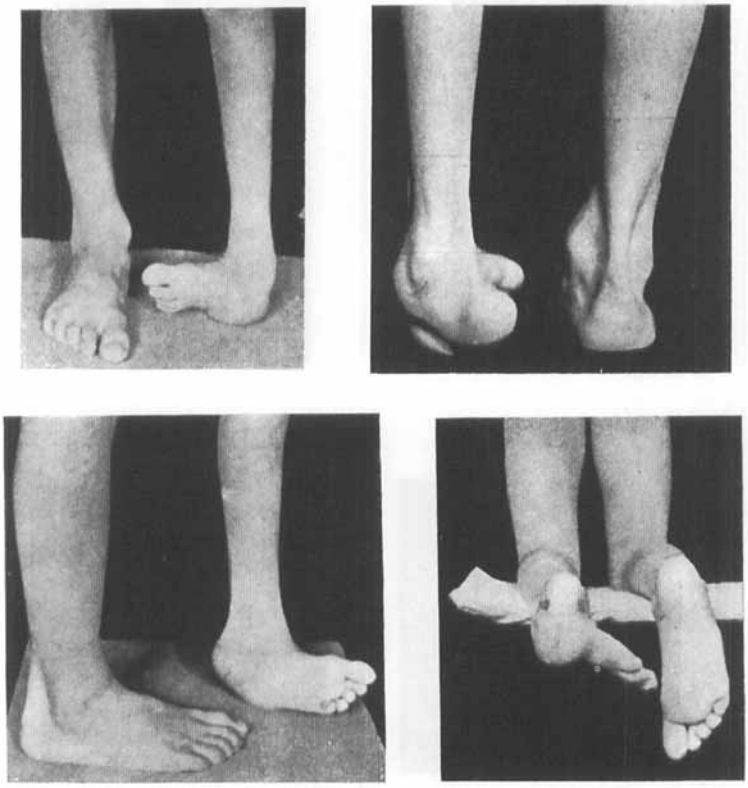


Fig. 8 a. Case 5.
Untreated club-feet in a boy aged 11 years. Considerable atrophy of the unused anterior part of the foot.

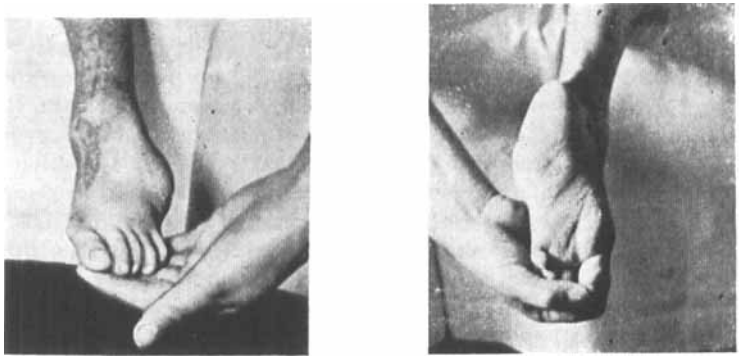


Fig. 8 b. Case 5.
The same patient after operation on the soft tissues. The bursa was not removed as it soon disappears spontaneously.

Fig. 8 c. Case 5.
One month after the last session. The great reduction in the size of the foot is not due to the operation as the width of the base of the wedges removed was only 3-4 mm. It is due to previous defective growth.

front of Chopart's joint with a 4-5 mm. wide base. Both were extra-articular. Thus the minimal amount of bone was removed and the size of the foot was not affected. (Fig. 8 c, 6 months after operation.)

3 years after operation his father wrote that: "The foot's position is the same as when he came home. He jumps about like other boys and one does not notice anything different about him. He uses ordinary shoes and does not turn them over. He moves his ankle well, though a little less than on the normal side." The questionnaire sent after 10 years was not answered.

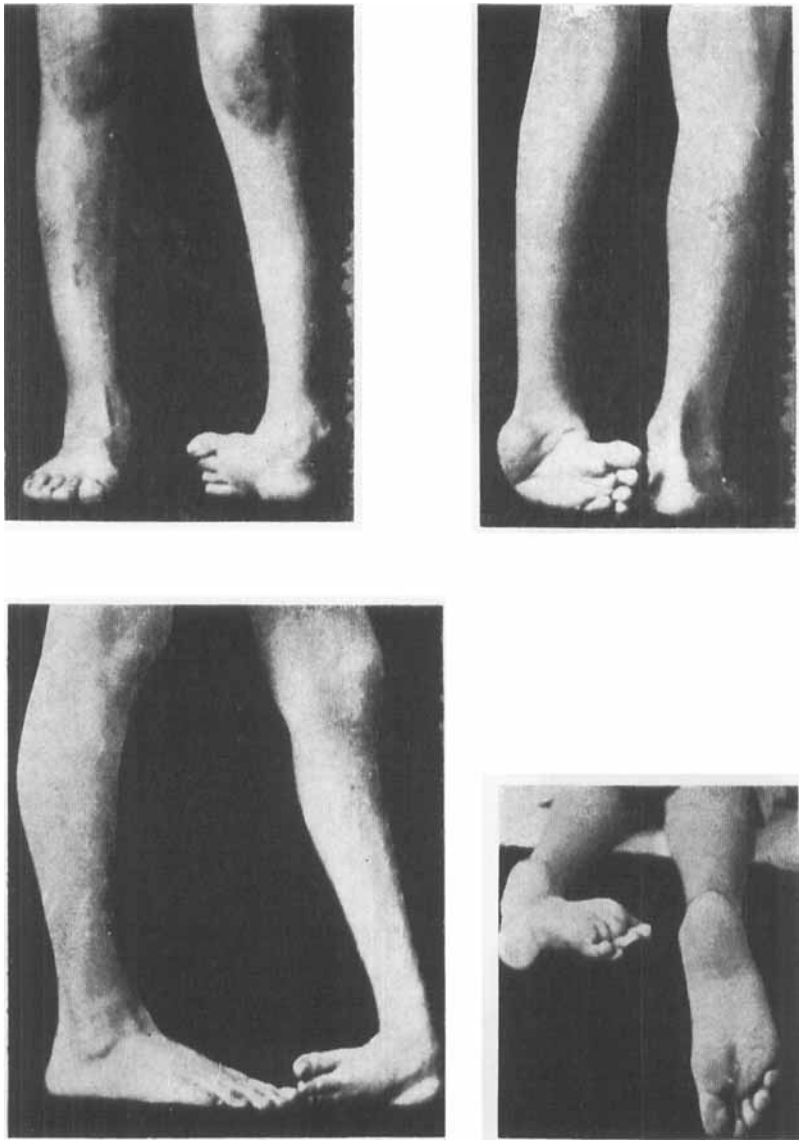


Fig. 9 a. Case 6.
Girl aged 14 years with untreated clubfoot.

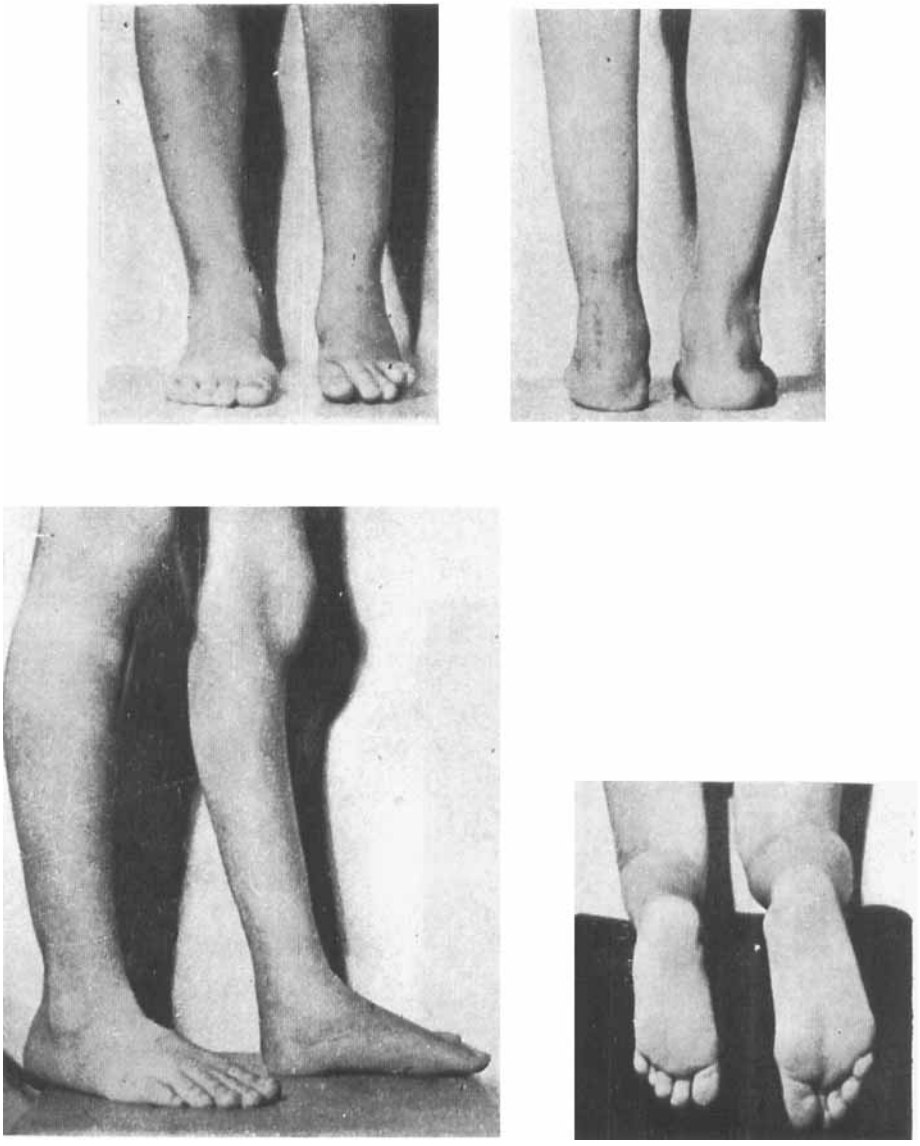


Fig. 9 b. Case 6.
Same patient 1 month after last session. In this case also the growth of the foot had previously been defective.

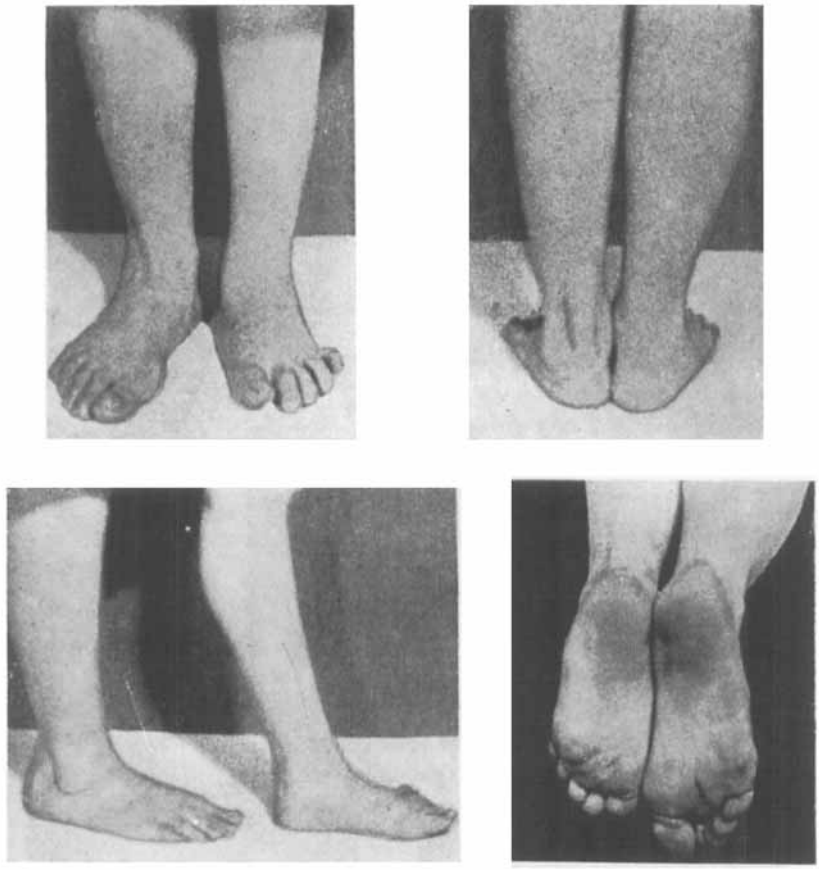


Fig. 9 c. Case 6.
Same patient 3 years after operation. Note the improvement in the markedly atrophic muscles of the calf.

Case 6. 14-years-old girl. No previous treatment of her L. clubfoot. 19.7.37. Operation by M. Gjessing, using the same technique as in the other cases. Figs. 9 a and b show the foot before and after operation. The patient wrote in July 1942, 5 years after operation: "No pain in the foot. Does not turn her shoes over. Moves the ankle up and down, a little less than on the normal side but not enough to trouble her. She wears ordinary ready-made shoes. She thinks the foot is much stronger than before operation." The photograph Fig. 9 c sent 2¾ years after operation shows, in addition to a normal-shaped foot, that the muscles

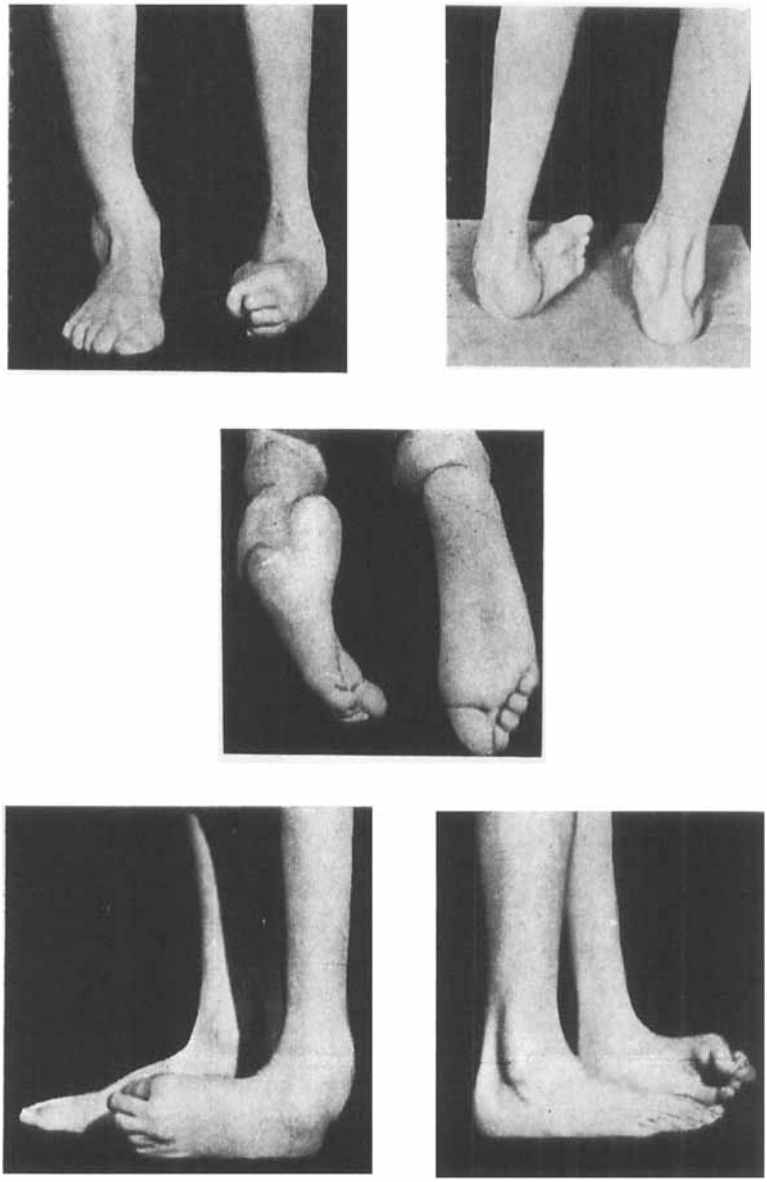
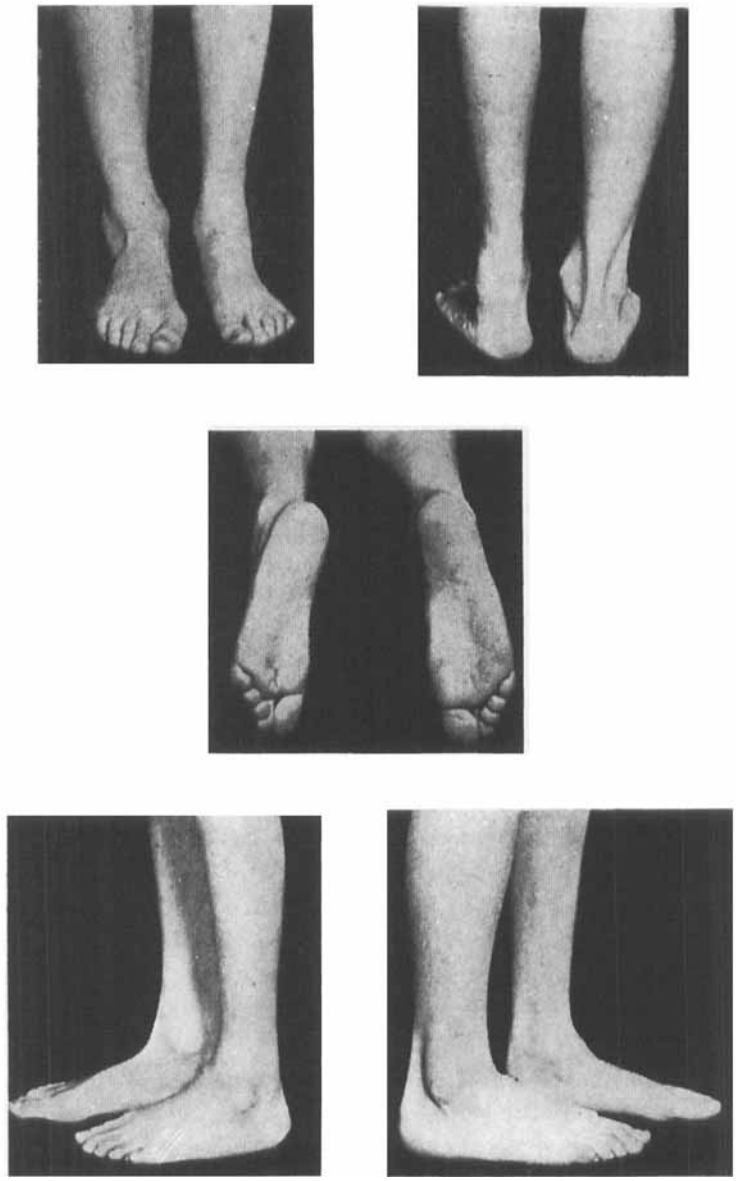


Fig. 10 a. Case 7.
10 a. Girl aged 10 years with untreated fixed equinovarus. There is a severe degree of fixed flexion contracture of the toes, especially of the big toe.



10 b. 3 years after operation. Normal shape and proportion of the foot. Takes part in ordinary school gymnastics, play and ski-ing., like the other children. Note the normal position of the big toe.

of the leg have developed considerably since operation. The foot is rather smaller than the L. but has not been reduced by the operation.

Case 7 (The Coast Hospital at Stavern.)

A 10-year-old girl. Previously untreated congenital pes equinovarus. There is a fixed varus and adduction deformity. Inflexion is less marked, *but there is a severe flexion contracture of the toes, especially the big toe.* (Fig. 10 a.)

1.3.45. First Session under Ether Anaesthesia (the author). The tendon of the tibialis posterior was not lengthened since it would be used for transplantation later. The flexor hallucis longus and flexor digitorum longus were lengthened and the flexion contracture of the toes straightened. In the same session arthrodesis was done with anterior and horizontal wedges under the talus. The biggest wedge was ½ cm. wide at the base.

Second Session. Lengthening of the tendo Achilles and transplantation of the tendon of the tibialis posterior to extensor hallucis longus (which appeared to have no action).

Fig. 10 b shows the condition 2 years after operation.

The patient's father wrote "she takes part in all games, school gymnastics, and ski-ing. The leg has become fatter and stronger. Active dorsi-flexion of the big toe is minimal, but there is no flexion contracture of the toes."

Discussion.

I have never seen circulatory disturbances after using the method described.

The patients have been given a pleasing foot-shape and the feet have not been reduced by the operation. They have not shown any evidence of relapse during follow-up periods of up to 8 years. Callosities on parts of the foot which have not previously borne weight, as those seen in Case 5, cannot detract from the value of the method and can be corrected by a minor operation later.

The time in Hospital has been between 3 and 4½ months, and is shorter if the patient lives near the Hospital and can stay at home between operations. After-treatment with splints and "clubfoot" shoes has not been necessary, and ordinary ready-made factory shoes have been used. In milder cases, such as Case 3, obviously not more than 2 or even 1 operation

is necessary since a bony operation alone may suffice. However, I believe that usually 2-3 sessions give better results. It is noticeable that none of the patients tends to walk with his feet turned in after the operation. The apparent turning-in of the foot in clubfoot is due to inversion at the talocalcaneal joints as pointed out by Günz, Thomasen and Wisbrun, and others, and not very often to a turning-in of the tibia. On the contrary a compensatory outward rotation occurs at the ankle-joint in older patients as described by Homan, Monberg and others.

Operations which overcome the inversion will also cause the turning-in to disappear. It is therefore, in older children and adults, unnecessary to do a rotation osteotomy of the tibia, such as Ragnar Magnusson, Campbell and others have used, in younger children, if the operation has been correctly carried out.

In 1946 Ragnar Magnusson published a study based on material from the Orthopaedic Clinic in Lund and from Göteborg on the subject of rotation osteotomies for this turning-in at the ankle. It is possible that this really does occur in the first years of life—but one must allow for the fact that in newborn infants there is physiologically 10° of internal rotation. But one may dare to believe that a fair number of the apparent inward rotations were measured by comparing the axis of the foot with the plane of the patella, since the plane of the tibial condyles is rather difficult to measure exactly in living subjects. Although the axis of the foot appears to be completely straightened—and both the supination and the adduction position seem to be corrected—I have usually found that on the radiographs of cases of turning-in of the foot in corrected clubfeet the inversion had not been corrected.

Magnusson, Campbell and other workers do not describe the inversion —and I cannot see that their cases have been radiographed to show it— so that one is not convinced that the turning-in of the foot in many of their patients really represents an internal rotation of the tibia.

There are 2 secondary changes which one cannot control and which may give rise to later troubles. They are:

1. As in patient no. 1 (Fig. 3). A compensatory valgus position at the ankle-joint, which, because of unequal weight-

bearing, can give a secondary arthrosis. In this case there has been no such complication over a period of 8 years.

2. As in patient no. 4, fig. 7 f. Marked disuse atrophy of the calcaneal process, which makes support at the heel insufficient. Actually, however, the main discomfort has been that the shoe slips off at the heel.

SUMMARY

The author describes the operation which he uses in severe degrees of clubfoot in older children and adults. As introduction he cites some of the cases operated before he came to the method he describes, and then cases which were operated by the method. The results are illustrated by short case histories, photographs and foot-imprints of 7 patients, 4 bilateral and 3 unilateral, who were aged between 11 and 29 years.

The longest follow-up was 8 years after operation. No case showed evidence of relapse. Altogether 14 patients were operated by the author himself by this method.

The author points out that neither tarsectomy nor subastragalar arthrodesis with removal of a bone is alone sufficient to ensure the best possible result in these severe degrees of club-foot, and an earlier warning example is quoted. He claims in opposition to a number of other writers that it is important that as *little* bone as possible be removed. After big tarsectomies the feet, even in successful cases, are small and clumsy. In unilateral cases there is already a big difference in size between the two feet, due in part to a developmental failure and partly to atrophy of parts of the foot which are not used. The difference must not be increased: by the method used here this is achieved without reducing the correction.

A further reason is that big resections which usually go well into the neck of the talus may lead to necrosis of the talus—though in the author's experience this happens less often than might be expected in theory.

The operation is carried out in 3 stages:

First Stage: The soft tissue operation is performed very thoroughly and absolutely anatomically, with preservation of the vessels and nerves. A plastic skin operation with epidermal transplants is done in cases where the operation wound cannot be closed after the correction. The effect of the soft tissue operation alone is illustrated by photographs.

Second Stage: Lengthening of the Achilles tendon. Detachment of the Achilles tendon and pulling down the heel with Schede's apparatus and inclusion of the wire through the calcaneus in the plaster.

Third Stage: A T-shaped wedge osteotomy with very little removal of bone.

The results are illustrated with photographs, follow-up studies and information sent by the patients up to 8 years after the operations.

A radiograph of a case of severe clubfoot with obvious compensating valgus position at the ankle joint is shown, and another with marked diffuse atrophy of the calcaneus process which was first seen after correction. The first might be expected to cause painful arthrosis in the talocalcaneus joint, but this had not developed during the 8 years the case was observed.

RESUME

L'auteur décrit l'opération qu'il pratique dans les cas graves de pied bot chez les enfants qui ne sont plus tout petits et chez les adultes. Il décrit tout d'abord quelques cas qui représentent le développement de la méthode et puis de cas opérés d'après cette méthode. Les résultats sont illustrés par de courtes observations médicales, des photographies et empreintes de pieds de 7 malades, 4 bilatéraux et 3 unilatéraux, âgés de 12 à 28 ans.

Un des cas a été suivi pendant 8 ans après l'opération. Il ne semble pas y avoir eu de rechutes. 14 malades ont été opérés par l'auteur.

Il est attiré l'attention sur l'insuffisance de la tarsectomie ou de l'arthrodèse sous-astragalienne avec coin pour obtenir

les meilleurs résultats dans les cas graves de pied bot — et un exemple antérieur est cité à titre d'avertissement.

En opposition avec un certain nombre d'auteurs, il est prétendu ici qu'il est important de réséquer une partie d'os aussi *petite* que possible. Après de grosses tarsectomies, même dans les cas opérés avec succès, le pied reste petit et large. Dans les cas unilatéraux, il y a déjà une grande différence de taille entre les deux pieds, due en partie à un développement vicieux et en partie à l'atrophie des parties du pied qui ne travaillent pas. Cette différence ne doit pas être accentuée : par la méthode utilisée ici, on y arrive sans réduire la correction.

Par ailleurs les importantes résections entrent d'ordinaire assez profondément dans la partie postérieure de l'astragale, ce qui peut entraîner la nécrose de cette dernière. Toutefois, d'après l'auteur, ceci arrive beaucoup moins souvent qu'on aurait pu s'y attendre théoriquement.

L'opération doit être pratiquée en trois phases :

1ère phase : Opération des tissus mous pratiquée très à fond d'une manière strictement anatomique, avec préservation des vaisseaux et des nerfs. Dans les cas où la plaie ne peut être refermée après l'opération, on procède à une opération plastique de la peau avec transplantation épidermique. Le résultat de l'opération des tissus mous est illustré par des photographies.

2ème phase : Allongement du tendon d'Achille. Détachement du tendon d'Achille et abaissement du talon au moyen de l'appareil de Schede et de l'inclusion dans le plâtre d'un fil traversant le calcanéum.

3ème phase : Ostéotomie d'un coin en forme de t, avec résection d'une très petite partie de l'os.

Les résultats obtenus sont illustrés par des photographies, l'étude suivie des cas et les indications fournies par les malades pendant une période qui a été jusqu'à 8 ans après l'opération.

Il est donné les radiographies d'un cas grave de pied bot avec compensation opposée en position valgus de l'articulation

de la cheville et d'un autre avec atrophie marquée d'inactivité de la tubérosité du calcanéum, constatée seulement après la correction. Dans le premier cas, on aurait pu s'attendre à une arthrose douleureuse de l'articulation astragalo-calcanéenne, mais celle-ci ne s'est pas produite durant les 8 années sur lesquelles l'observation de ce cas s'est étendue.

ZUSAMMENFASSUNG

Verfasser beschreibt die Operation, die er bei schweren Graden von Klumpfuss bei älteren Kindern und Erwachsenen anwendet. Er beschreibt zuerst einige Fälle, die er operierte, bevor er zu der Methode gelangte, die er später angewandt hat, und die die allmähliche Entwicklung zu dieser Methode repräsentierten. Dann beschreibt er Fälle, die nach dieser Methode operiert wurden. Die Ergebnisse werden mit kurzen Krankengeschichten, Photographien und Fussabdrücken von 7 Patienten illustriert, 4 bilateralen und 3 unilateralen Fällen im Alter von 12 bis 28 Jahren.

Die längste Nachbeobachtung dauerte bis zu 8 Jahren nach der Operation. Kein Fall zeigte einen offenkundigen Rückfall. 14 Patienten wurden vom Verfasser operiert.

Beachtlich ist die Unzulänglichkeit der Tarsektomie oder Subtalo-Arthrodese mittels Keil-Operation, um bei diesen schweren Graden von Klumpfuss das bestmögliche Ergebnis zu erzielen —, und ein früheres warnendes Beispiel wird angeführt. Verfasser behauptet, im Gegensatz zu einer Reihe anderer Autoren, es sei von Wichtigkeit, dass so *wenig* Knochen wie möglich entfernt werde. Nach grossen Tarsektomien sind die Füsse, auch in erfolgreichen Fällen, klein und unschön, plump. In unilateralen Fällen besteht bereits ein bedeutender Grössenunterschied der beiden Füsse, teils infolge einer Fehlentwicklung und teils infolge einer Atrophie von Teilen des Fusses, die nicht gebraucht werden. Dieser Unterschied darf nicht vergrössert werden: Bei der hier angewendeten Methode wird dies ohne Verringerung der Korrektur erreicht.

Ein weiterer Grund ist der, dass grosse Resektionen, die gewöhnlich ein gutes Stück in den Hals des Talus eindringen, zu einer Nekrose des Talus führen können, obschon dies nach der Erfahrung des Verfassers seltener geschieht, als es theoretisch zu erwarten wäre.

Die Operation wird in 3 Etappen durchgeführt:

Erste Etappe: Die Weichteilsoperation wird sehr gründlich und absolut anatomisch ausgeführt mit Bewahrung der Gefässe und Nerven. Eine plastische Hautoperation mit Epidermis-Transplantation wird in Fällen vorgenommen, wo die Operationswunde nach der Korrektur nicht gedeckt werden kann. Die Wirkung der Weichteilsoperation allein wird durch Photographien illustriert.

Zweite Etappe: Verlängerung der Achillessehne. Ablösung der Achillessehne und Herabziehen der Ferse mit Hilfe des Schede'schen Apparats und Einschliessung des durch den Calcaneus gezogenen Drahts in Gips.

Dritte Etappe: Eine t-förmige Keil-Osteotomie mit Entfernung einer sehr geringen Knochenmasse.

Die Ergebnisse werden durch Photographien, Nachuntersuchungen und Mitteilungen der Patienten bis zu 8 Jahren nach der Operation illustriert.

Eine Röntgenaufnahme eines Falles von schwerem Klumpfuss mit deutlicher Kompensation der Valgus-Stellung des Fussgelenks wird gezeigt und eine zweite mit ausgesprochener Atrophie durch Nichtgebrauch des Tuber calcanei, die erst nach der Korrektur zu sehen war. Im ersten Falle könnte man die Entstehung einer schmerzhaften Arthrosis der Articulatio talocalcanea erwarten, dies ist jedoch in den 8 Jahren, in denen der Fall beobachtet wurde, nicht eingetreten.

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