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THE TREATMENT OF CLUB-FOOT AND ITS RESULTS

A Follow-up Study

By

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There are several theories as to the etiology of *talipes equinovarus*. An early one is that in which the deformity is considered to be conditioned by a mechanical misplacement of the feet of the foetus *in utero*, with subsequent contractions of the soft parts, fixing the foot and giving it the characteristic *equinus*, *varus* and *adductus* components after partus (3). Particularly in recent years, however, several authors, such as, *inter alia*, *Bechtol & Mossman*, *Flinchum*, *Fredenhagen*, *Hirsch* and *Stewart* (2, 4–6, 13), have investigated club-feet and have pointed out anomalies in ligaments, muscles and tendon attachments, which might explain the deformity. Nothing certain is yet known, however, as to whether these anomalies arise on a genetic basis or as a result of some harmful influence on the foetus during a sensitive stage in its development. On the basis of these findings many authors have therefore adopted the view that the cause is a non-physiological functioning of certain muscles, tendons and ligaments in the foot, by which the static and dynamic characteristics of the foot are altered, with subsequent secondary deformations of the skeletal structure.

As regards the general principles of treatment for congenital club-foot, the majority of authors are today fairly unanimous. Attempts are made to improve the anatomical conditions at as early a stage as possible, by means of repeated manipulative measures and subsequent fixations by various methods. Only when the corrective measures taken in hospital do not prove to be sufficiently effective or in the case of a relapse are operative measures resorted to. When the Orthopaedic Clinic at Uppsala came into being in the autumn of 1955, treatment at first followed the general principles mentioned above. However, as there was dissatisfaction with the results of this treatment, as in other

quarters where treatment of club-feet has been undertaken, on account of the many cases which did not yield to therapy and which relapsed, new therapeutic methods were tried after a year or so. Attention was principally centred on the medial part of the foot and a number of surgical explorations were made medially across the tarsus, with resection of the ligamentum deltoideum. *Hirsch* (6) has previously described this technique. The present investigation has been carried out primarily to get an idea of the results of the treatment of club-foot worked out in the last few years at the Uppsala Clinic.

MATERIAL

Between November 1955 and May 1962, 70 patients with pure *talipes equinovarus congenitus* were registered at the Clinic. Thus, this number does not include cases which showed, in addition to club-foot, other malformations such as arthrogryposis, *luxatio coxae congenitus*, aplasiae, finger anomalies, etc.

The investigation includes the club-foot patients who were treated primarily or secondarily during the first few years of life at the Uppsala Clinic and hence not the cases which received primary treatment at another place and, for various reasons, came to Uppsala for further treatment several years later. The material includes 31 patients, all born after January 1954. Of these, 30 came to the follow-up examination. Twenty (67 per cent) of those examined were boys and 10 (33 per cent) girls. In 12 patients there were bilateral deformities, in 11 in the right foot and in 7 in the left foot, so that the total number of club-feet was 42 (Table 1).

The observation period, *i.e.* the period between the beginning of the treatment and the follow-up examination, varied between 2 and 8.5 years and was on the average 4.3 years.

TABLE 1
Distribution by sex and lateral localization of the deformity.

	Boys	Girls	Total
Bilateral	7	5	12
Right-sided	7	4	11
Left-sided	6	1	7
Total	20	10	30

METHODS

At the examination the parents were questioned as to the possible occurrence of *pes equino-varus* in their nearest relations. The circumstances of the actual pregnancy were also investigated, especially with regard to possible virus infections, supply of known teratogenic drugs or the influence in other respects of possible factors producing malformations during the first few months of pregnancy.

The results of treatment were partly assessed by ordinary *clinical* examination, after which it was possible to divide the material into "good", "fairly good" and "poor" cases. In addition all the feet were examined by radiography.

I. Clinical Examination.

(a) "*Good*" result. No lameness, dorsal flexion in the talocrural joint to at least 0°, plantar flexion to at least 30–35°, calcaneus in medial position between pronation and supination, possibly with some range of movement in either or both directions, and a moderate degree of adduction of the forefoot to a maximum of 10°.

(b) "*Fairly good*" result. Only a hint of lameness, no dorsal flexion, possibly *pes equinus* of up to 10°, plantar flexion of between 25° and 30°, a slight but clear supination of the calcaneus without any pronation from this position and an adduction of the forefoot of 10–25°.

(c) "*Poor*" result. Inferior to (a) and (b) above.

An ordinary dorso-plantar projection was used in the radiographic investigation, in order to get an idea of the degree of inversion of the tarsus by recording primarily the relative positions of the talus and the calcaneus. In inversion in the foot there is a reduced angle between the longitudinal axes of the bones mentioned, owing to the fact that the talus is projected over the calcaneus (7, 14) (Fig. 1). An additional idea of the foot's degree of inversion was obtained by the so-called suro-plantar projection described by Kandel (7) (Fig. 2). Kleiger & Mankin (9) have also described a similar method.

The material was divided into three groups with regard to age at the beginning of treatment: Group I, younger than 1 week (8 cases); Group II, 1–3 weeks old (12 cases); Group III, 3 weeks to 3 months old (10 cases).

The results of treatment were compared with the average fixation time in plaster of Paris between each redression in the various patients. The results were also correlated to the length of the primary period of

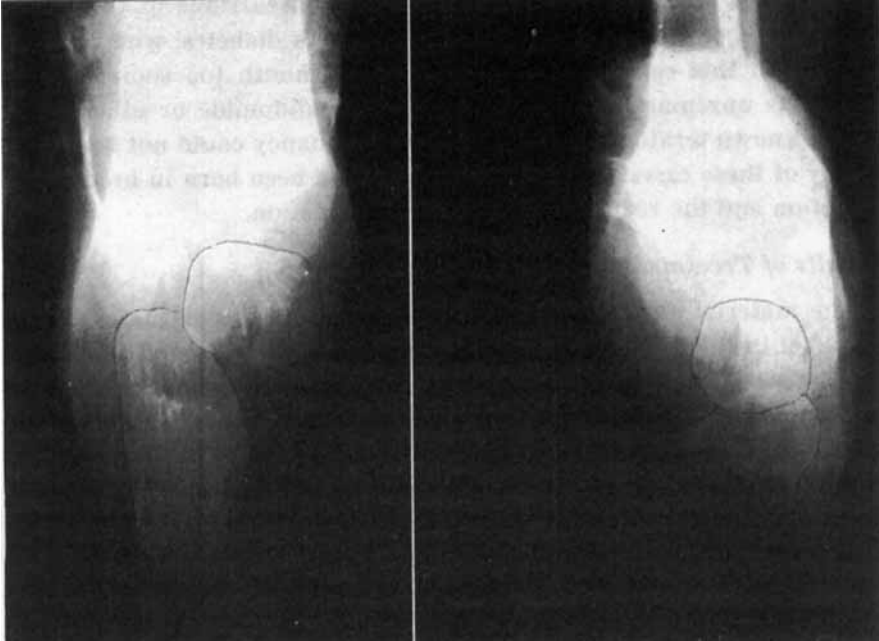


Fig. 1.

Dorso-plantar X-ray photograph. Six-year-old girl with bilateral club-feet. The right foot clinically "fairly good" and the left foot "good". The angle between talus and calcaneus abnormally small bilaterally, most pronounced in the right foot. Naviculare displaced medially with reduced supporting surface towards the talus in the right foot. Bilateral adduction of the forefoot, most pronounced in the right foot.

treatment. By this period is meant the time during which the patient was treated with preliminary redressions and fixations, up to the time when the deformity was considered to have been corrected and a beginning was made with a night splint. Thus, in difficult cases a surgical operation may also have been carried out during this period.

The number of operations of various types was recorded and the results were analysed. As regards patients who had been operated on several times, the results of the follow-up examination could accordingly be assigned only to the latest operation.

*Fig. 2.*

"Suro-plantar" X-ray photograph. Four-year-old boy with right-sided, clinically "poor" club-foot. Left foot normal. Both talus and calcaneus somewhat hypoplastic in the right foot. Right calcaneus supinated. Right talus lies cranially of the calcaneus, whilst the left talus lies medially of the upper pole of the calcaneus. Fibula is projected over the tibia on the right but not on the left side.

RESULTS

Hereditary Occurrence.

In a total of 12 cases (40 per cent) there was a congenital club-foot deformity in the family. These cases were distributed as follows: (I) in the same generation (brothers and sisters) 2; (II) in a direct line upwards (father) 1, (grandfather) 2; (III) collaterally (paternal uncle or aunt) 2, (cousin) 1, (more distant relations) 4.

Pregnancy.

One mother had fallen ill with "Asiatic influenza" in the third or fourth month of pregnancy. Another suffered a severe infection of the upper respiratory tract in the fourth month. Both of them were treated with sulpha drugs and the lungs of the second were X-rayed in connection with the infection. Two mothers had slight haemorrhages in the

third month and one was treated with a miscarriage in the fourth month. One patient was born of a mother with diabetes, who required insulin. In this case partus was induced a month too soon but was otherwise unremarkable. Consumption of thalidomide or other drugs with a known teratogenic effect early in pregnancy could not be proved in any of these cases. Two of the patients had been born in breech presentation and the remainder in vertex presentation.

Results of Treatment.

The material has been collated in Table 2. "No." designates all the club-feet in the 30 patients investigated. These were graded as "good", "fairly good" and "poor" after clinical assessment by the method described above. The results were "good" in 31 per cent, "fairly good" in 43 per cent and "poor" in 26 per cent.

Table 3 shows the results in Groups I, II and III, which have been defined in detail under "Methods". In each of Groups I and II 29 per cent were "good" and 57 per cent and 50 per cent respectively were "fairly good". Group III showed "good" results in 36 per cent. The results in Groups I and II were "poor" in 14 per cent and 21 per cent respectively and in Group III 43 per cent.

TABLE 2
Result at the follow-up examination after "clinical" assessment.

Result	Result of clinical examination			
	Good	Fairly good	Poor	Total
No.	13	18	11	42
Per cent ...	31	43	26	100

TABLE 3
Result at the follow-up examination compared with the child's age at the beginning of treatment.

	Group I		Group II		Group III		Total	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Good	4	29	4	29	5	36	13	31
Fairly good	8	57	7	50	3	21	18	43
Poor	2	14	3	21	6	43	11	26
Total	14	100	14	100	14	100	42	100

TABLE 4

Result at the follow-up examination correlated with the length of the primary treatment period.

Primary treatment period	Clinical result, per cent			No.
	Good	Fairly good	Poor	
0-3 months	33	40	27	15
3-6 months	25	50	25	16
Over 6 months	36	36	28	11

TABLE 5

Number of operations of various types carried out on the whole material.

Type of operation	No.
Achillotomy + possible capsulotomy	19
Achillodeltoideotomy	27
Transposition of tibialis post	8
Rotation osteotomy of tibia	7
Total	58

The average fixation times in plaster of Paris between each redression in the various groups with "good", "fairly good" and "poor" results turned out to be, broadly speaking, equal.

The largest number of "good" results (36 per cent) had a long period of primary treatment (over 6 months) but even with primary treatment for at most 3 months the results were "good" in 33 per cent. The frequency of "poor" results was about the same, irrespective of the length of the period of primary treatment (Table 4).

All except six of the club-feet examined had been subjected to some form of surgical operation. The number of operations of various types appears in Table 5, which shows a clear preponderance of achillodeltoideotomies. The results of the various operations are shown in Table 6. In fixing a basis for these calculations, regard was paid only to the latest operation carried out on the patient, in accordance with the statement in "Methods" above. The percentage figures in the table show the best results following achillodeltoideotomies and tendon transpositions and the worst following achillotomy. Of the six patients not operated on, three were "good" and three "fairly good" at the examination.

More or less serious deviations from the normal picture were recorded

by X-ray in 40 (95 per cent) of the club-feet investigated. Thus, from the radiographical point of view, only two (5 per cent) of them had been completely corrected.

TABLE 6
Result of follow-up examination after various types of operation.

Result	Achillotomy		Achillodel- toideotomy		Tendon trans- position		Rotation osteotomy	
	No.	per cent	No.	per cent	No.	per cent	No.	per cent
Good	—	—	7	28	1	25	1	20
Fairly good	1	50	10	40	2	50	4	80
Poor	1	50	8	32	1	25	—	—
Total	2	100	25	100	4	100	5	100

DISCUSSION

This follow-up study cannot be considered to reflect any finality as regards the treatment of club-foot but would seem to be able to give some guidance as to certain principles in such treatment.

The material contains about twice as many boys (67 per cent) as girls (33 per cent), figures which are in good agreement with what other authors (5, 10–12) have found previously.

In 40 per cent of the patients there was club-foot in the family. This is a strikingly high percentage and greatly exceeds, for example, *Fredenhagen's* result (14.5 per cent) (5). This difference, compared with previous results, can probably be largely ascribed to a chance accumulation asserting itself strongly in the present small material.

The attempt at an etiological analysis as regards the possible occurrence of teratogenetic factors during an early stage of pregnancy can scarcely be considered to have yielded any decidedly positive result. A single, diagnostic, X-ray examination of one mother in the fourth month of pregnancy probably cannot be assigned any teratogenic effect. The treatment of chick embryos with sulpha drugs has previously been reported to produce malformations (1) but the dosage was then so large that the mortality was 100 per cent. For this reason the short treatment of two mothers with therapeutic doses of sulpha drugs at an early stage of pregnancy cannot have played any part in the origin of the deformity. Nor can the slight haemorrhage noted in two women easily have had any teratogenic effect.

The results of treatment were "poor" in 26 per cent of the material

as a whole. Thus, there were satisfactory ("good" or "fairly good") results in 74 per cent, which, broadly speaking, agrees with the follow-up studies of other authors (5, 10, 12).

Table 3 shows that the frequency of "poor" results increases the older the child is at the beginning of treatment. Thus, in the present investigation 14 per cent were "poor" and 86 per cent satisfactory in Group I (younger than 1 week at the beginning of treatment). The corresponding values in Group II (1-3 weeks old) were 21 per cent and 79 per cent and in Group III (older than 3 weeks) 43 per cent and 57 per cent. There are accordingly greater chances of achieving satisfactory results with redressions and fixations initiated early on, as has also been remarked by several authors (5, 12).

It was not possible to show any great difference between patients with periods of primary treatment of different lengths, as regards the result of treatment. In this case, however, another factor, viz. the degree of initial deformity, plays a part. It was unfortunately not possible to map this out on the basis of the journal notes. It may be considered as self-evident that a moderate club-foot can be corrected as well in a short period of primary treatment as a severe one in a longer period. Most people engaged in the treatment of club-foot find that the risk of relapse is greater when the primary treatment is concluded early. However, the doctor in charge of the treatment will often conclude the fixation in plaster of Paris relatively early, in order to counteract atrophy of the calf and stiffness in the foot by functional treatment, and he therefore generally attempts to strike a balance between the two requirements.

Nineteen achillotomies (Table 5) were carried out in the whole material. In 17 of these cases a further surgical operation was performed in the subsequent course of the treatment. This seems to argue that in these cases unsatisfactory results were achieved with achillotomy. However, this is not the whole truth, as it must be remembered that achillo-deltaideotomy was performed in several cases chiefly for diagnostic purposes and then often after achillotomy had previously been performed, perhaps with tolerably satisfactory results. Achillodeltoideotomy shows the largest number of "good" results. However, it is impossible in this small material to make any safe comparison between the results of the different types of operation, especially as it was not possible to establish the degree of deformity which existed before the various operations. As regards the achillodeltoideotomies, which primarily yielded good results (6), relapses have been recorded in several

cases, with tight scar formation medially across the tarsus. So the problem of loosening the tight soft parts in the ligamentum deltoideum and its environment without postoperative scar formation seems still to be unsolved. In order to achieve a permanent good result, however, it is important that the foot be fixed for a sufficiently long time after the operation. This is in agreement with the good results reported by *Pasila & Sulamaa* (11) after early modified Brockman operation with subsequent prolonged fixation. For the present, however, better results are probably achieved with prolonged correction and fixation treatment.

The radiographical examination may be regarded as a sensitive method of showing deviations in the normal anatomy of the foot. In the present investigation there was more or less pronounced inversion in the tarsus in as high a percentage as 95 per cent. In a large number of these radiographically unsatisfactory cases the results from the clinical point of view were "good" or "fairly good". In many intractable cases it is hardly possible to achieve a normal X-ray picture with any form of therapy. If, however, there are doubts as to whether a club-foot has been corrected or not, an X-ray picture of the foot skeleton can give good guidance as to whether continued correction and fixation are necessary or not.

A strikingly large number of the cases investigated had persistent, more or less pronounced, forefoot adduction. One conceivable cause of this deformity is the fact that their night splints to a large extent only fixed the lower leg and foot without reaching up to the thigh, for which reason the foot had some possibility of being adducted.

The result of the investigation is not really satisfactory, though it is largely in agreement with what other investigators have found (5, 10, 12). Relapses were very common, even after the deformity seemed to have been completely corrected. This was particularly the case if correction had been achieved as early as after 2–3 months of primary treatment. To achieve a more permanent result, fixation after initial redressions should consequently be continued for a long period, perhaps up to a year. However, as so long a period of fixation in plaster of Paris produces pronounced calf atrophy and rigid feet, it is desirable that a fixation material should be produced that will also allow, despite the fixation, a certain use of the feet and leg. Experience also shows that it is very important to initiate therapy as early as possible.

SUMMARY

A follow-up study of a material consisting of 30 patients with a total of 42 club-feet is presented. The result was good in 31 per cent, fairly good in 43 per cent and poor in 26 per cent. There was a better result when treatment was initiated early. The most successful operation was achillodeltoideotomy, which in a number of cases, however, produced deforming, medial, scar contractions and relapses. The radiographic picture showed more or less pronounced and persistent deformity of the foot skeleton in 95 per cent.

The early initiation of redressions and corrections, which should continue for several months and, if possible, result in a normal X-ray picture, must be considered to be important. Only after this treatment is it possible to go over to night splints, which should then reach up to the thigh. In cases very resistant to therapy and in pronounced relapses operative measures may be resorted to.

RESUME

Le réexamen d'un matériel d'observation comptant 30 malades avec un nombre total de 42 pieds bots est présenté. Le résultat a été bon dans 31 pour cent, relativement bon dans 43 pour cent, et médiocre dans 26 pour cent. Le résultat a été meilleur lorsque le traitement avait été instauré très tôt. L'opération ayant le mieux réussi a été l'achillodeltoïdeotomie qui a néanmoins dans un certain nombre de cas provoqué une déformation médiale, des contractions cicatricielles et des rechutes. Le tableau radiographique montre une déformité plus ou moins prononcée et persistante du squelette du pied dans 95 pour cent des cas.

L'entreprise précoce du redressement et de la correction qui doivent se poursuivre durant plusieurs mois pour arriver si possible à un tableau radiographique normal, est considérée comme très importante. C'est seulement après ce traitement qu'il est possible de penser aux éclisses la nuit, celles-ci devant aller jusqu'à la cuisse. Dans les cas très résistants à la thérapie, avec des rechutes prononcées, il faut alors avoir recours également à une intervention chirurgicale.

ZUSAMMENFASSUNG

Eine Nachuntersuchung eines Materials von 30 Patienten mit einer Gesamtanzahl von 42 Klumpfüßen wird dargeboten. Das Ergebnis war gut in 31 Prozent, halbwegs gut in 43 Prozent und schlecht in 26 Prozent. Ein besseres Ergebnis wurde erzielt wenn mit der Behandlung

frühzeitig begonnen wurde. Die erfolgreichste Operation war die „Achillodeltoideotomy“, die jedoch in einer Anzahl von Fällen eine Deformierung, mediale Narbenkontraktur und Rückfälle hervorrief. Das Röntgenbild zeigte mehr oder weniger ausgesprochene und beharrende Verbildung des Fuss skelettes in 95 Prozent.

Der frühzeitige Beginn der Redression und Korrekturen, die während mehrerer Monate fortgesetzt werden sollten und wenn möglich ein normales Röntgenbild ergeben sollten, muss als wichtig angesehen werden. Nur nach dieser Behandlung ist es möglich auf Nachtschienen, die dann bis zum Oberschenkel reichen sollten, überzugehen. In Fällen, die sich gegenüber der Behandlung als sehr hartnäckig erweisen und bei ausgesprochenen Rückfällen muss zu operativen Massregeln gegriffen werden.

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