CONGENITAL TALIPES EQUINOVARUS: II. A STAGED METHOD OF SURGICAL MANAGEMENT

R. W. PORTER

From Doncaster Royal Infirmary

A staged method of surgical management for congenital talipes equinovarus is described. The hindfoot was corrected and rebalanced early in 125 feet, and in 66 feet a second-stage medial forefoot correction was performed in the second, third or fourth year. The hindfoot relapsed in 19% and the forefoot in 9%; these feet were treated by further soft-tissue surgery. No bony operation was necessary. Assessment before and after operation allows comparison with other series.

The principles of surgical management of congenital talipes have been recognised from the mid-nineteenth century (Syme 1863) but many different methods of correction are still practised. This paper describes a personal series of a staged surgical procedure, designed to achieve and maintain correction, with defined input and output criteria which allow comparisons with other methods.

MATERIALS AND METHOD

This is a personal series of 87 children, born in Doncaster between January 1970 and December 1985, with congenital talipes equinovarus as an isolated abnormality that did not correct by six weeks of age.

In the first six weeks of life, most of the deformed feet were treated by serial plaster correction, avoiding forced stretching and manipulation. A few feet with mild deformity were left to resolve spontaneously, and latterly some with gross deformity were untreated prior to surgery (Fig. 1). Surgery was recommended when the deformity did not resolve by six weeks of age. The calcaneus was high in the heel pad of fat; and the feet generally had a persisting posterior skin crease and would not correct to the neutral position.

The severity of the original deformity was recorded photographically from the resting forefoot supination at birth, and at six weeks of age from a lateral soft-tissue radiograph of the calf (see Part I).

Stage 1. Hindfoot correction and rebalance through a posterior incision was carried out after six weeks of age, as soon as the child was considered fit for surgery. This was performed on 125 feet.

Through a posterior incision, slightly to the medial side, the calcaneal tendon is exposed and divided sagittally in a Z fashion. The underlying flexor hallucis longus is gently retracted to the medial side, protecting the neurovascular bundle, and the posterior surface of the lower tibia and ankle joint are exposed. With small blunt dissecting scissors the posterior capsule of the ankle joint is incised, and by dorsiflexing the foot, the body of the talus usually fills the ankle mortise. To obtain full correction of the talus in the ankle joint, it may be necessary to extend the capsulotomy onto the medial side, to divide the inferior tibiofibular ligament and release the lateral tether between the calcaneus and the lateral malleolus (Scott, Hosking and Catterall 1984).

The tendons of the tibialis posterior, flexor digitorum longus and flexor hallucis longus are divided in a Z fashion, and resutured in a lengthened position. Through the same posterior incision, the tendon of peroneus longus is exposed, and shortened by about 1 cm, reefing and suturing it first with catgut and then with a non-absorbable suture. The calcaneal tendon is sutured in a lengthened position.

Through a small medial forefoot incision, the tendon of abductor hallucis is tenotomised. The corrected foot is supported in an above-knee plaster backslab for two weeks (Fig. 2). The sutures are then removed under general anaesthesia, and the foot over-corrected in plaster for a further two weeks. Thereafter the foot is free of plaster and splints (Fig. 3).

Stage 2. Forefoot correction through a medial incision was carried out when necessary in the second or third (or more rarely, the fourth) year, on those feet with more than 20° of resting or standing forefoot adduction. There were 66 feet that underwent this stage.

Through a curved medial incision, convex upwards, the joints on the medial side of the foot are approached

R. W. Porter, MD, FRCS, FRCS Ed, Consultant Orthopaedic Surgeon Doncaster Royal Infirmary, Armthorpe Road, Doncaster DN2 5LT, England.

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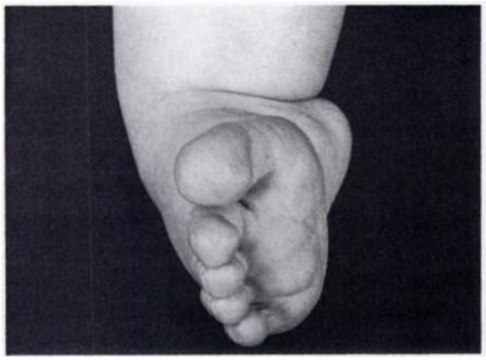

Fig. 1

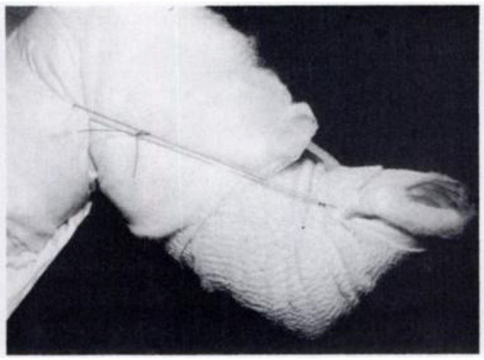

Fig. 2

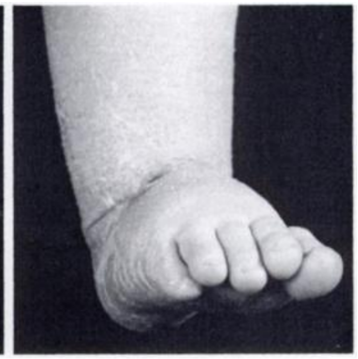

Fig. 3

Figure 1 – Congenital talipes equinovarus in an eight-week-old baby, uncorrected prior to surgery. Figure 2 – The foot of this same baby held postoperatively in the corrected position by nylon, sutured to strapping applied over wool. Figure 3 – The corrected deformity at 12 weeks (four weeks after surgery).

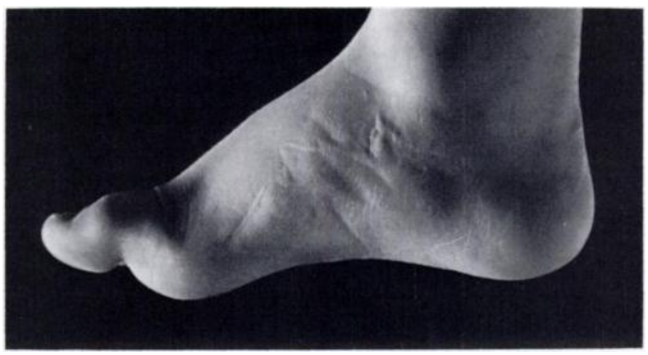

Fig. 4

Z-plasty of the skin after capsulotomies to prevent a contracting scar spoiling the result.

and defined with small blunt curved dissecting scissors. The capsule on the medial aspects of the talo-navicular, naviculo-cuneiform, and cuneiform-metatarsal joints is divided, extending the incisions onto the volar and dorsal aspects, until the foot can easily be corrected by passive abduction. The tendon of the abductor hallucis is tenotomised, and the skin sutured with Z-plasty to prevent a contracting scar spoiling the result (Fig. 4). The foot is supported in a below-knee plaster in the over-corrected position for 12 weeks.

Assessment

The children were assessed clinically and radiologically at 4, 8, 12 and 16 years of age. At 16 years of age they were asked about pain and discomfort during and after activity, and about inhibition of sporting and recreational activities. The clinical assessment recorded the range of passive dorsiflexion and plantarflexion using a goniometer (Fig. 4 in Part I), and the degree of resting forefoot adduction and passive abduction. Radiographic assessment was from Beatson's combined talo-calcaneal angle (Beatson and Pearson 1966), the talo-navicular angle (Main and Crider 1978), the navicular to first metatarsal angle (Lowe and Hannon 1973) and the tibio-talar angle (Simons 1985).

Recurrence of hindfoot deformity was treated by a second posterior capsulotomy, when there was failure to dorsiflex the ankle to neutral actively and a premature heel lift-off when walking. Forefoot relapse with a return of 20° of forefoot adduction was treated by repeating the second-stage operation.

RESULTS

The first-stage correction was carried out on 125 feet in 87 children; 66 feet required the second-stage forefoot correction, 42 in the second year, 21 in the third and three in the fourth year of life. The other 47% had remained acceptable after the first-stage procedure alone, and have not, as yet, required the second medial operation (Figs 5 to 8).

After the first-stage correction, 19% of feet subsequently had a second posterior capsulotomy, and 2% required a third. After the medial forefoot correction, 9% had a second medial soft-tissue release. No surgery was necessary after five years of age, no child required a bony

Table I. Comparison of the 55 feet which had their first-stage procedure early with the 21 feet which had it late

	Age at first stage		p value of difference
	< 24 weeks	> 24 weeks	
Deformity			
At birth forefoot supination (*degrees*)	93.2 ± 10.9	72.2 ± 23.3	< 0.01
At 6 weeks tibia to calf muscle ratio	5.1 ± 0.7	4.6 ± 0.6	< 0.01
Clinical assessment at 4 years (*degrees*)			
Dorsiflexion	17.5 ± 9.5	24.5 ± 10.6	< 0.01
Plantarflexion	32.4 ± 12.9	35.0 ± 14.1	NS
Resting adduction	10.0 ± 6.8	8.6 ± 6.4	NS
Passive abduction	14.2 ± 6.9	16.2 ± 7.4	NS
Radiographic assessment at 4 years (*degrees*)			
Beatson's combined angle	59.4 ± 20.0	58.4 ± 19.7	NS
Talo-navicular angle	86.2 ± 13.6	100.8 ± 18.2	< 0.05
Naviculo-metatarsal angle	75.5 ± 12.0	79.6 ± 13.9	NS
Tibio-talar angle	37.4 ± 13.3	38.2 ± 15.8	NS

operation, and no child wore splints or special footwear. Six children were lost to follow-up.

At the time of the first operation, 73% of feet were in children under 24 weeks of age and at four years of age their results were less satisfactory than those of the children who had delayed surgery (Table I). The mean ankle dorsiflexion was significantly less ($p<0.01$) and the forefoot adduction measured by the talo-navicular angle significantly greater ($p<0.05$). However, their degree of original deformity was also greater.

There was a significant relationship between the severity of the original deformity (measured by forefoot supination at birth and tibial length to calf muscle ratio at six weeks) and the ankle dorsiflexion at four years of

Fig. 5

Fig. 6

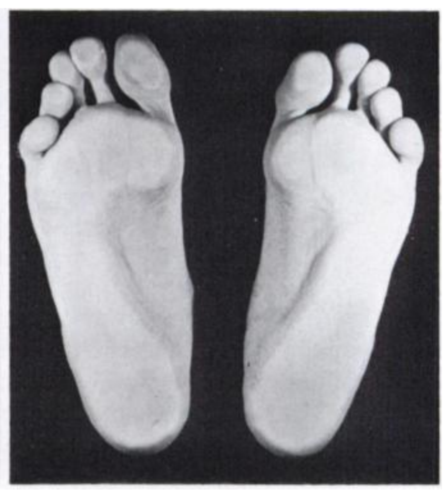

Fig. 7

Figures 5 and 6 Bilateral talipes equinovarus at birth with 100° of resting forefoot supination.

Figures 7 and 8 The feet of the same subject at 17 years of age. He had one bilateral posterior release operation at six weeks of age.

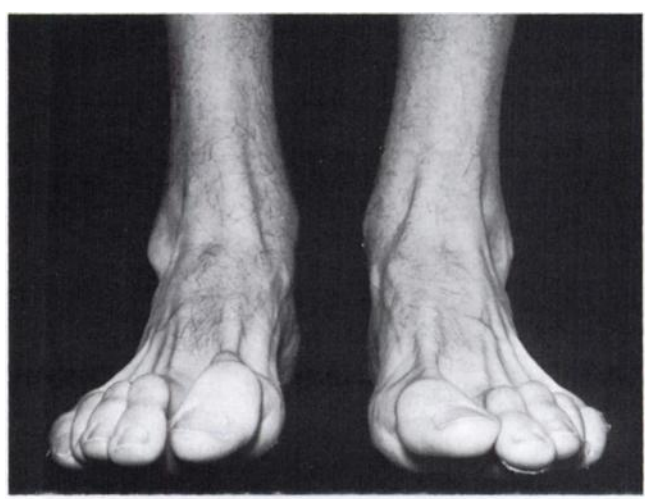

Fig. 8

Table II. Comparison of deformity and assessment in relation to the operations required to achieve correction

	Operations performed		
	One-stage $n = 27$	**Two-stage** $n = 24$	**>2 operations** $n = 25$
Deformity			
At birth – forefoot supination (*degrees*)	82.1 ± 10.8	87.5 ± 22.8	92.7 ± 16.9
At 6 weeks – tibia to calf muscle ratio	5.03 ± 0.78	5.73 ± 0.83	5.07 ± 0.65
Clinical assessment at 4 years (*degrees*)			
Dorsiflexion	23.9 ± 9.2	19.0 ± 10.4†	15.6 ± 8.5‡
Plantarflexion	33.2 ± 12.8	30.3 ± 14.0	26.7 ± 13.7
Resting adduction	7.8 ± 6.2	9.2 ± 6.5	11.3 ± 6.9
Passive abduction	18.8 ± 5.6	13.8 ± 5.8†	17.6 ± 7.6
Radiographic assessment at 4 years (*degrees*)			
Beatson's combined angle	69.7 ± 19.6	64.5 ± 17.2	60.5 ± 18.3
Talo-navicular angle	91.7 ± 14.8	95.5 ± 12.0	85.5 ± 16.2‡
Naviculo-metatarsal angle	83.0 ± 14.8	77.4 ± 13.5	74.6 ± 18.5
Tibio-talar angle	36.0 ± 11.2	42.5 ± 14.0	35.8 ± 14.3

† Significantly different from one-stage result at $p < 0.01$
‡ Significantly different from two-stage result at $p < 0.05$

Table III. Clinical and radiographic assessment at 4, 8, 12, and 16 years of age

Age (*years*)	**Mean clinical range (*degrees*)** DF	PF	Add	Abd	**Mean radiographic angle (*degrees*)** Beatson's	Tal/Nav	Nav/Mt	Tib/Tal
4	22.40	34.14	4.83	16.48	67.54	83.68	82.12	26.38
8	21.21	31.34	4.36	16.01	72.56	92.46	85.67	42.43
12	18.33	31.85	4.42	16.53	78.40	89.78	82.25	40.00
16	15.00	29.40	5.41	12.50	68.51	95.10	82.00	34.50

DF, dorsiflexion; PF, plantarflexion; Add, adduction; Abd, abduction
Tal/Nav, talo-navicular; Nav/Mt, naviculo-metatarsal; Tib/Tal, tibio-talar

age ($r = -0.48$, $p < 0.005$, and $r = -0.69$, $p < 0.01$), but there were no useful correlations with other clinical and radiological measurements.

The number of operations required to maintain an acceptable correction is compared with the severity of the original deformity in Table II. There was no significant difference in resting forefoot supination at birth between the feet requiring a one-stage procedure and those requiring a two-stage procedure or those that relapsed and required further surgery. The difference in tibial length to calf muscle ratio at six weeks of age between the feet requiring a one-stage and a two-stage correction was only weakly significant at $p < 0.1$.

The success of treatment measured by clinical and radiographic methods at four years of age was inversely related to the number of operations needed to achieve correction (Table II), though feet having a one-stage or a two-stage procedure had significant differences only in the range of ankle dorsiflexion and forefoot abduction ($p < 0.01$). Those having more than two operations had significantly poorer results only in ankle dorsiflexion and in the radiographic talo-navicular angle ($p < 0.05$).

The clinical and radiographic assessment at 4, 8, 12 and 16 years of age is shown in Table III. Feet which were clinically acceptable at four years of age did not relapse. All the children played sports, some to a high standard, although approximately half the children complained of aching legs after exercise.

DISCUSSION

The principles of treatment for congenital talipes were described by Syme in 1863: surgery should be early, it should correct the deformity, and that correction should be maintained. The application of these principles has removed the stigma of club foot, but most surgeons are disappointed that their efforts still meet with only varying degrees of success. Can the principles be more effectively applied?

Timing. The safety of neonatal anaesthesia has made early surgery possible (Attenborough 1966). Main et al. (1977) first suggested that results were greatly superior if surgery was undertaken early, but later agreed that the outcome was not directly related to age (Green and Lloyd-Roberts 1985). In this series, children having surgery after 24 weeks of age had a slightly better outcome than children having surgery before 24 weeks of age, but they also had a lesser degree of original deformity. There is no evidence that the results relate to the timing of surgery.

One would expect early surgery to assist in the remodelling process, but it is justifiable to postpone surgery until the tissues are large enough to be handled with confidence. Injury to growing epiphyses and iatrogenic scarring from rough handling of tissues can subsequently spoil an otherwise good correction. Delay for a few weeks with a full correction, is preferable to a prematurely half-corrected foot, or a foot that will relapse from iatrogenic scarring.

The pre-operative management involved gentle correction and serial plasters, not stretching and forcible manipulation. This series may therefore include some children who in other hands would have been effectively treated conservatively. It has yet to be proved, however, that surgery can be avoided by the skilful application of plasters and splints. In the past, feet were treated conservatively, producing a legacy of deformed feet, many requiring bony salvage operations. The price of manipulation is sometimes a spurious correction (Swann, Lloyd-Roberts and Catterall 1969; Lloyd-Roberts, Swann and Catterall 1974; Addison, Fixsen and Lloyd-Roberts 1983) with damage to neonatal cartilage (Denham 1967). The absence of the "rocker bottom" and "bean-shaped" foot justifies a gentle approach to pre-operative management.

Correction. Various surgical techniques compete in their ability to correct the deformity. Attenborough (1966) demonstrated that if the hindfoot was corrected by dorsiflexing the talus, the supinated forefoot also corrected. This can be achieved by a posterior capsulotomy of the ankle joint, sometimes extending to the medial side, with division of the inferior tibiofibular ligament, and division of the lateral tether. It will provide lasting correction for many feet. Subsequent medial surgery is necessary when forefoot adduction remains.

The advocates of the pan-talar release operation (Turco 1971, 1979; Ghali et al. 1983; Simons 1985) correct both hindfoot and forefoot deformity at one stage, but such a radical procedure is unnecessary for every foot. Until we can identify those feet which will require both hindfoot and forefoot correction, it is reasonable to offer staged surgery. Radical correction may also be at the expense of stiffness and reduced function (Laaveg and Ponseti 1980; Green and Lloyd-Roberts 1985), perhaps because surgery to the medial side of the foot in very young children is technically difficult (Main and Crider 1978). All agree that correction must be adequate, and that it is best achieved at the first attempt, whether staged or radical.

Maintenance. If correction is not maintained, the foot will relapse. The cause of relapse and its prevention is not agreed, but balance may be important. In this series the first-stage correction incorporated a rebalancing operation designed on the premise that correction of the deformity had produced an iatrogenic imbalance (Fig. 9). The invertors and supinators were tight, and the evertors and pronators loose. The foot will tend to relapse in the same manner that a corrected paralytic deformity will relapse unless rebalanced (Sharrard 1957). Three invertor tendons were therefore lengthened to removed a deforming force, and the evertor and pronator, peroneus longus, shortened to redress the imbalance caused by the surgical correction (Fig. 10).

When Wylie (1959) immobilised the feet of young rabbits in dorsiflexion, it took up to 23 weeks for the musculotendinous units to grow into rebalance. One would likewise expect a gradual rebalance of the musculotendinous units if a corrected talipes is maintained in postoperative and night splints. Active eversion of the corrected foot is usually delayed (Turco 1979), but the shortened peroneus longus functions quickly, with no need for splints. This shortened abductor also redresses forefoot imbalance (Fig. 11).

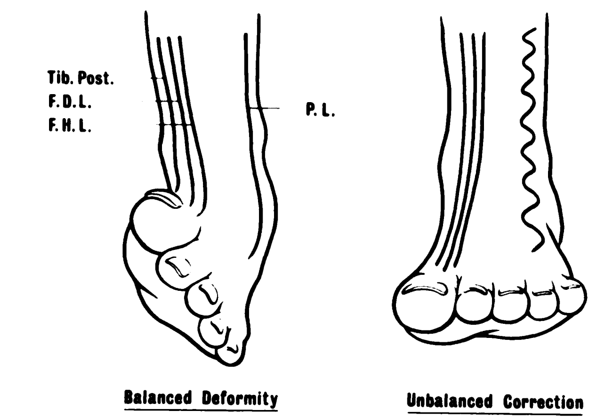

Fig. 9

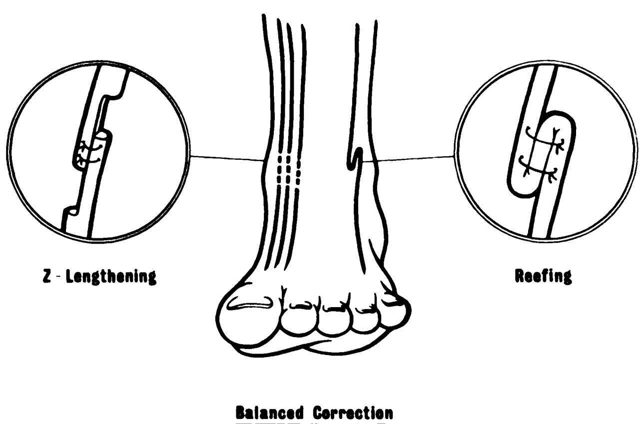

Fig. 10

Figure 9 - Diagram to show that correction of deformity will produce muscle imbalance, with tight tibialis posterior (Tib. Post.), flexor digitorum longus (F.D.L.) and flexor hallucis longus (F.H.L.) and a loose peroneus longus (P.L.) tendon. Figure 10 - A balanced correction requires lengthening of the three invertor tendons, and shortening of the peroneus longus.

A successfully corrected talipes should be plantigrade and pliable, or it will become painful and functionally poor. A plantigrade foot, the minimum requirement of treatment, can always be achieved by osteotomy if soft-tissue correction has failed. In this series, no foot required osteotomy to produce a plantigrade foot. The cost of osteotomy is loss of mobility; bony surgery limits function to such an extent that Green and Lloyd-Roberts (1985) classified all such feet as "poor".

This series had a 19% relapse rate of the hindfoot, and 9% relapse of the forefoot, both of which became and remained plantigrade after further soft-tissue surgery. These feet were less mobile than those which remained corrected after primary surgery, but we cannot compare the results with bony surgery until joint movement is routinely recorded in the assessment of different treatment methods. Lack of agreed criteria makes comparison difficult, but Beatson's combined talo-calcaneal angle has gained greatest acceptance (Laaveg and Ponseti 1980; Hutchins et al. 1985). In this series four radiological measures of joint anatomy, four clinical movements and a functional assessment compare favourably with other methods.

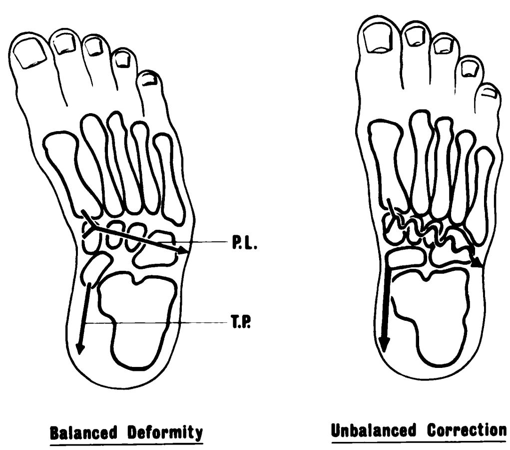

Fig. 11

Diagram showing forefoot imbalance produced by correction of the deformity. P.L., peroneus longus; T.P., tibialis posterior.

In the final analysis, the judge of a satisfactory foot is the patient (Bjönness 1975), making functional assessment at maturity essential. The premature tiredness of atrophied muscles is common, but only rarely does it prevent children with corrected talipes from competing successfully in school sports.

Conclusion. A staged procedure, incorporating early rebalance of the musculotendinous units, is recommended as a satisfactory method of management for talipes equinovarus. There appears to be no disadvantage in leaving forefoot correction until the second year. The relapsed foot is probably the result of mismanagement, which includes mistiming, iatrogenic epiphyseal damage, inadequate correction, imbalance and feet which slip out of postoperative plasters. Failure rests more in the surgeon's hand than the child's foot.

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