THE KITE TREATMENT OF CONGENITAL TALIPES EQUINO-VARUS

By A. T. FRIPP, F.R.C.S., and MARTIN SINGER, F.R.C.S.
Institute of Orthopaedics, Royal National Orthopaedic Hospital, London

Introduction

Among English surgeons interested in the deformity of club foot, the early work of W. J. Little stands out. Himself a victim, he travelled to the Continent and submitted to a tenotomy, which was performed by Stromeyer. Subsequently he practised the operation in England, and his book, published in 1839, is based on his experiences. But even more important than the introduction of tenotomy was his statement:

'In many cases the slightest pressure exercised by the instrument will suffice to overcome the deformity without producing pain, provided attention be daily paid and the straps and screws be tightened whenever they become loosened by the progress which the foot makes in the required direction. The surgeon must constantly bear in mind that after the performance of an operation he must not always expect to restore the foot rapidly to its material position; he must guard against violence.'

Later, in 1866, William Adams wrote:

'The principles of treatment and the complete and permanent curability of the affection have been satisfactorily determined beyond the possibility of doubt'.

That statement should give us cause to review the success of our methods, for there are still many old club foot patients haunting out-patient departments; but, as they are dubbed 'chronics,' they are apt to be seen by the surgeon's deputy and to him falls the task of ordering new surgical shoes. Today, provided that the treatment is started soon after birth and is carried out efficiently and continuously, a considerable proportion of club feet are well corrected with excellent end results; but there remain a group of children from the age of six months upwards in whom either correction has never been complete or in whom relapse has occurred. An intercurrent illness may have prevented regular attendance at hospital; facilities may not have been available, or treatment may not

have been efficiently carried out or, in cases of severe deformity, the foot may defy the efforts of any surgeon in the first few months of life.

In 1949 a group of young American and Canadian orthopaedic surgeons visited Great Britain. They expressed surprise at the fact that practically nowhere had they seen the method of Kite used in the treatment of club feet, although the method is widely used in the United States and has been practised for many years. Their comments provided a useful stimulus and a Kite clinic was started at the Royal National Orthopaedic Hospital and has now been in existence for more than three years.

Although Kite claims no originality, he re-emphasized the underlying principles of conservative treatment and was the first to elaborate the technique of correction by serial wedged plasters.

We are not concerned in this paper with the early treatment but with the problems of children, aged six months upwards, who have an incompletely corrected talipes equino-varus.

Principles of the Kite Method

There are four components in the deformity of club foot:

1. Forefoot adduction.
2. Inversion of the heel.
3. Equinus.
4. Plantaris (forefoot equinus).

The principle of the Kite method is that each component is corrected separately and in the above order, and no attempt is made to progress to the next stage until the first has been fully corrected. A padded plaster is applied; a wedge is cut out designed to correct one component and the plaster reconstituted with the wedge partially or completely closed. The process is repeated, usually at weekly intervals, until full correction of each component is secured. No anaesthetic is used, therefore the pressure exerted must cause no pain.

FIG. 1.—Standard Club Foot Position. The radiograph is taken with the child seated on a low box, the feet being held side by side on the cassette. The leg-foot angle is obtuse, so that the shadow of the distal end of the tibia does not overlap the talus. For clarity the X-ray tube has been lowered.

This limits the force used so that no trauma is inflicted on the bones, joints or ligaments of the foot.

The importance of correcting the components *seriatim* must be stressed. If an attempt is made to save time by starting on equinus before the other two stages are completed, the scaphoid is forced up on the inner side of the head of the talus instead of being brought into its proper alignment. The correction is spurious and relapse will follow. The degree of equinus present never becomes apparent until the varus and inversion have been corrected (W. J. Little wrote of converting *talipes varus* into *talipes equinus*), and in the early stages of treatment it may be quite difficult to apply any walking appliance on this account.

Gentleness and patience are essential, as the time taken may be several months; but, apart from the weekly visit to hospital, the child's life is but little upset and the psychological damage of repeated anaesthetics and painful feet is abolished.

Technique

At the first attendance each patient is X-rayed in the standard club foot position (Fig. 1). During the period of wedging, periodic X-rays are taken to help in assessing the degree of correction obtained.

The success of the method depends upon meticulous attention to detail and team work.

1. The surgeon holds the limb, grasping the second and third toes between the thumb and forefinger of one hand and steadying the knee with the other hand. In the first two stages no attempt is made to correct the equinus, and as the varus is corrected it becomes obvious that the foot must be held in marked equinus.

2. An assistant first applies the padding and then the plaster. We have found that the proprietary preparation 'Orthoban' is the most convenient material for padding.

3. The 'Orthoban' and plaster are always put

FIG. 2.—Application of 'Orthoban' and Plaster. Each turn of the wool and the plaster bandage is applied in the direction which assists correction.

on from *without inwards*, starting across the top of the foot, i.e. each turn of the wool and the plaster bandage is applied in the direction which assists correction (Fig. 2).

4. *Application of the 'Orthoban':*

(a) The big toe should be completely covered.
(b) Each turn should overlap half the breadth of the previous turn.

(c) Spiral upwards from the heel, stopping just below the knee joint.

(d) Pressure occurs at three points where sores may form:

- (i) Medial border of the big toe.
- (ii) Outer border of the foot.
- (iii) Point of the heel.

An extra layer of wool is used to cover these.

(5) *Application of the plaster* (Fig. 2):

(a) Two rolls of 6 in. bandage are usually enough; 4 in. bandage is used for small children and infants.

(b) The plaster tends to fray and soften at each end and therefore a strip of plaster 2 in. wide is added to reinforce the cast.

(c) As soon as the plaster has been applied, the assistant steadies the knee and the surgeon rapidly changes his grip—if the left foot is being corrected the left hand grips the forefoot with the thumb on the dorsum and the fingers on the plantar aspect; the thenar eminence is along the medial border. Pressure is exerted along a horizontal axis, and care is taken to avoid the tendency to pronate the forefoot. The right hand grips the hind foot with the thenar eminence against the lateral aspect and

FIG. 3.—The 'Varus' Wedge. The apex is on the inner side over the mid-tarsal joint and the base is on the outer side over the cuboid.

the fingers against the medial aspect. This grip is maintained until the plaster has set.

(d) Above-knee plasters are used only for children who have not started to walk.

6. *Wedges.* The appropriate wedge is marked as soon as the plaster has been applied. At the next attendance the wedge is cut out with a small hand saw. One should be careful not to disturb the underlying plaster wool, otherwise the skin may easily be nipped when the wedge is closed.

Four different wedges are used:

(a) The 'varus' wedge with the apex on the inner side over the mid-tarsal joint and the base on the outer side over the cuboid (Fig. 3).

(b) The 'inversion' wedge with the apex over the medial malleolus and the base from the tip of the lateral malleolus extending above the level of the ankle joint (Fig. 4).

(c) The 'equinus' wedge with the apex posteriorly at the level of the ankle joint and the base over the dorsum of the ankle (Fig. 5).

(d) The 'plantaris' wedge with the apex at the tip of the heel and extending forwards and upwards to the dorsum of the ankle (Fig. 6).

Note that a bridge of plaster is left at the apex of each wedge.

After the wedge has been removed, the surgeon

FIG. 4.—The 'Inversion' Wedge. The apex is over the medial malleolus and the base extends from the tip of the lateral malleolus to above the level of the ankle joint.

FIG. 5.—The 'Equinus' Wedge. The apex is situated posteriorly at the level of the ankle joint and the base over the dorsum of the ankle.

FIG. 6.—The 'Plantaris' Wedge. The apex is at the tip of the heel and extends forwards and upwards to the dorsum of the ankle. Note: A bridge of plaster is left at the apex of each wedge.

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FIG. 7.—Correction after Removal of Varus Wedge. Pressure is exerted along a horizontal axis only and the degree of pressure is just short of causing pain.

corrects the foot as far as possible; this is just short of causing pain (Fig. 7). This position is maintained by closing the gap with plaster. One 6 in. bandage is found to be sufficient for an older child. If the wedge has not been completely closed the assistant covers the gap with one layer of wool before applying the plaster, so that removal the following week is simplified. The plaster should be of sufficient thickness to withstand the strain of walking, but not so thick as to impede the cutting of the wedges.

In closing a varus wedge it is important not to pronate the forefoot or to force it up into dorsiflexion. The amount of correction obtainable at

one manipulation varies considerably, depending partly on the severity of the deformity and partly on the amount of fibrosis left from earlier forcible manipulations. But it is surprising how much a foot 'softens up' during the treatment, and many feet are more supple at the end of treatment than at the beginning, in spite of—or perhaps because of—the immobilization.

At each change of plaster the child's foot and leg are carefully washed and dried. No particle of plaster should be left on the skin as it may cause a pressure sore. Every time the plaster is changed the knee, if enclosed, is put through a full range of movement.

Modifications of Kite's Technique

As our experience of the method increased Kite's original technique was modified.

1. *An above-knee plaster* is only used before the child is old enough to walk. With a short plaster the child is much happier because his activities are virtually not interfered with; also, the musculature of the calf is given every chance to develop and the blood supply to the foot is adequately maintained.

2. A 'rocker' (Fig. 8) is used for all below-knee plasters.

3. *The 'plantaris' wedge.* We use this wedge—with the apex at the tip of the heel—in any case where there is a residual plantaris deformity after the hind foot equinus has been fully corrected by the equinus wedge. Kite points out that this wedge affects the mid-tarsal joint and not the ankle joint, and that in using it there is a risk of producing a rocker foot. This risk is fully appreciated and must be guarded against. Careful use of this wedge greatly facilitates the correction of the residual plantaris deformity, and a rocker foot has not resulted in any of our cases.

4. *Period of retentive plaster.* In view of the tendency to relapse in any club foot, Kite uses a retentive plaster for six months following the corrective period, and as an alternative we have adopted a routine tendon transplant of tibialis anterior to the outer side of the foot. Neither the principle nor the practice of this procedure is new and has been described previously. The transplant goes a long way towards correcting the muscle imbalance due to relative peroneal weakness, which is one factor in causing a relapse, and it has the great advantage that it materially shortens the time of treatment. It should be emphasized that the transplant must not be done until full correction has been secured.

Criteria of Correction

These are clinical and radiographic. Clinically all the elements of the deformity must be capable of being over corrected passively and, when the foot is in repose, it should show no tendency to revert to the deformed position. The tibial tubercle should be in line with the first and second toes.

Radiographically in the antero-posterior view the long axis of the talus should pass through the scaphoid and the medial cuneiform and along the first metatarsal. Until forefoot correction is complete, the scaphoid lies to the inner side of the head of talus and the talo-metatarsal line is a curve, concave inwards. Secondly, there is an angle of 35° between the long axis of the talus and that of os calcis, but if the heel is inverted the os calcis rolls under the talus through a vertical and a horizontal axis, so that the shadows of the two

FIG. 8.—Rocker. A 'rocker' is used as a walking appliance. It is particularly useful when the foot is in extreme equinus.

bones are superimposed and the talo-calcaneal angle is reduced or obliterated. Correction is not complete until the os calcis is seen to the outer side of the talus and the angle has been restored (Fig. 9).

TABLE I

Number of:				
Patients Treated	..	..	..	66
Feet Treated	..	..	..	83
Average Length of Time to Correct:				
Varus	..	..	..	11.9 weeks
Inversion	..	..	..	4.2 "
Equinus	..	..	..	6.0 "
Plantaris	..	..	..	6.0 "
Average Total Length of Time to Correct Deformity	..	..	..	21.6 "
Average Number of:				
Varus wedges	..	..	..	8
Inversion Wedges	..	..	..	4
Equinus Wedges	..	..	..	4
Plantaris Wedges	..	..	..	4

FIG. 9.—Radiographs of a normal foot (R) and of congenital talipes equino-varus (L). Note (R): The shadows of talus and os calcis are clearly differentiated, while the talus points towards the first metatarsal and the scaphoid is in front of the head of the talus. Note (L): (a) There is no talo-calcaneal separation, and the outlines of these two bones are almost superimposed; (b) The talus points in the direction of the fourth and fifth metatarsals; (c) The scaphoid is on the anteromedial aspect of the head of the talus.

Kite uses an additional factor in assessment—in the lateral view of a dorsiflexed foot the margins of the os calcis and talus are in line; whereas in the incompletely corrected equinus the os calcis is displaced posteriorly. For the correction of the equinus clinical assessment has been found more valuable than radiographic. The latter does not take into account the residual plantaris deformity.

Snags and Difficulties

1. *Plaster sores.* These are usually caused by faulty technique, e.g. the big toe not being completely covered by plaster.

2. *Associated congenital abnormalities.* These abnormalities, e.g. talo calcaneal synostosis and absent metatarsals increase both the difficulty of correction and the liability to recurrence.

3. *Previous bone operations* with attempts at bony fusion lead to a rigid foot which is not amenable to this treatment.

4. *Age.* From eight years upwards we have found that the feet respond less and less.

5. Occasionally there is a marked discrepancy

between the clinical and radiographic appearances; with a good clinical correction the scaphoid may remain on the inner side of the talus in spite of prolonged varus wedging. In our experience this is one of the indications for operation discussed below. Similarly the shadow of the talus may remain superimposed on that of the os calcis when the heel inversion appears to be well corrected. In the few cases that we have observed where good clinical correction has been secured there has been no relapse.

Discussion

In putting the case for the Kite method of treatment, a brief consideration of the alternatives is essential:

1. Splints and alterations to shoes. These are quite ineffective and can neither bring about correction nor prevent further relapse.

2. Forcible correction under anaesthesia. It is a common experience that a considerable degree of apparent correction can be secured, but after three or four manipulations the recurrence rate is high and the procedure often has to be repeated after a few months. When force is used in manipulation the position of the scaphoid frequently remains unchanged; Parker's capsule is a thick and inelastic structure but the medial scapho-cuneiform and the cuneo-metatarsal ligaments, being relatively weak, are stretched and spurious correction occurs at these joints. There is no justification for the claims that, if sufficient force is used, any deformity can be overcome without injury to the foot. Both the subsequent X-ray appearances and operative findings with deformed bones and arthritic joints condemn this line of treatment. It is inevitable that forcible manipulation traumatizes the soft tissues and this leads to fibrosis and a progressively rigid foot. Thus a vicious circle is established and more violence is required to overcome the rigidity. In contradistinction it is quite striking how often a foot, initially stiff and resistant, 'softens up' during the period of wedging.

3. Operations. This method does not entirely avoid the necessity for operation, but it reduces the frequency and a course of Kite plastering before surgical intervention makes the residual deformity easier to correct. This method produces a much more satisfactory foot than early bone operations, which should rarely be necessary.

The equinus component of the deformity is due primarily to disproportion between the talus and the tibio-fibular mortice rather than shortening of the Achilles tendon. This accounts for the failure to secure adequate dorsiflexion after lengthening the Achilles tendon. The only logical way of dealing with the equinus is by serial wedging and

it is reasonable to assume that the tibio-fibular mortice and the talus are gently and gradually moulded during the course of this wedging.

We consider that two operations have a definite place in treatment. Firstly, a soft tissue correction when varus wedging fails to bring the scaphoid into its proper alignment, and secondly a tendon transplant of tibialis anterior to the outer side to correct the muscle imbalance. Where forefoot adduction is associated with a valgus hindfoot a tendon transplant is contraindicated.

The Kite method suffers from none of the disadvantages of the alternative methods of treatment. It inflicts no pain on the child and no trauma on the foot; correction is methodical and the degree of correction can be accurately estimated. The child can live a healthy active life during treatment and schooling is not interfered with. The increased length of time is a small price to pay for a supple, well balanced, plantigrade foot.

Criteria of Success

Any treatment must stand or fall by its results, and it is pertinent to consider what is the aim in the treatment of a club foot. The foot should be free from pain, plantigrade and supple, with good muscle balance and of near-normal shape.

It is economically and aesthetically desirable to be able to wear ordinary shoes, and this demands a foot of a shape and size approaching the sound foot.

A tarsectomized foot is often broad and will not fit a shop shoe. Any varus deformity causes heavy wear on the outer side and may ruin a shoe in a few weeks. A supple foot with good muscle balance will stand up to the strains of life better than a rigid one.

It may not be possible to fulfil all these criteria, and occasionally a foot defies treatment, however skilful, but in our experience the Kite method, either alone or in conjunction with operations, offers the best prospect of cure in the highest proportion of cases.

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