THE CORRECTION OF FOOT DROP IN LEPROSY*

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Foot drop from paralysis of the muscles of the anterior and lateral compartments of the leg is common in leprosy. Often associated with anaesthesia, it is a challenge to the surgeon who seeks to rehabilitate the patient. The patient, unaware of unusual stresses on his foot because of the neurotrophic lesions, may allow a deforming force to continue until an ulcer is formed; hence it is of the utmost importance that any deformity of the foot in a patient with leprosy should be so completely corrected that no other deformity or disability will occur as a result of surgery (Fritschi and Brand 1957).

Many methods of correcting the functional problems associated with a foot drop have been tried with the object of providing a foot that is stable and socially acceptable. Surgical means provide the most permanent correction and give the best cosmetic results (Ober 1933). Transfer of the tibialis posterior tendon to the front of the foot through the interosseous membrane has proved satisfactory, and in most patients is devoid of serious complications (Gunn and Molesworth 1957, Brand 1964). Nevertheless, in the Chinese patients at the Hay Ling Chau Leprosarium a regularly recurring list of complications has followed the routine use of this method, when followed up for five to six years.

COMPLICATIONS OF TIBIALIS POSTERIOR TRANSFER

The commonest complications encountered are as follows. 1) Inadequate elevation of the foot because of undue lengthening of the tendon. 2) Inversion or eversion of the foot related to the placement of the new insertion and the pull on any remaining muscles; 3) talo-navicular collapse (Andersen 1964, Paterson and Job 1964, Harris and Brand 1966), which may occur without operation and is not of necessity associated with any obvious infection. In reconstructive surgery the first indication occurs some two to four weeks after the removal of the plaster, when the patient starts to walk again. The foot becomes warm and slightly swollen but there is usually no discomfort. A radiograph may show osteoporosis only at this time but if walking is allowed freely and radiography is repeated in six weeks the early signs of bone breakdown will often be seen. Early detection and immobilisation for up to six months in a walking plaster can lead to complete recovery without deformity; neglect may lead to increasing bone destruction and to loss of the arch with lateral deviation of the forefoot. This condition of talo-navicular collapse is believed to be caused by unnoticed injury to the anaesthetic foot. However, it has been assumed that surgical intervention with the tarsal bones must increase the tendency to bone breakdown after surgery. The new technique described has therefore avoided tendon-to-bone union and has utilised a tendon-to-tendon technique, which requires only three weeks in plaster and therefore there is less osteoporosis. 4) Instability of the talo-navicular joint which may be associated with some breakdown of the cuboid bone or the calcaneus and results in lateral deviation on the forefoot. This is assumed to be connected with removal of the support of the talo-navicular joint that is provided by the tibialis posterior tendon (Last 1963). 5) Dropped toes caused by laxity of the tendons of the paralysed extensor digitorum longus when the ankle once again assumes the right angled position and the pull of the tendons of the flexor digitorum longus shortened by the dropped foot position. This may cause the patient to walk on the nails of the toes

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TABLE 1
COMPARISON OF THE OLD AND NEW METHODS IN CASES 1 AND 2

Case number	Side	Sex	Age in years	Method and date of operation	Movement	Angles before operation in degrees			
1	Right	Male	70	Old October 1964	Passive dorsiflexion	85			
					Active dorsiflexion	—			
					At rest	115			
					Active plantar-flexion	120			
	Left			New May 1965	Range	5			
					Passive dorsiflexion	85			
					Active dorsiflexion	—			
					At rest	115			
				Active plantar-flexion	128				
				Range	13				
				<hr/>					
				2	Left	Male	31	Old June 1964	Passive dorsiflexion
Active dorsiflexion	—								
At rest	125								
Active plantar-flexion	140								
			New May 1965		Range			15	
					Passive dorsiflexion			88	
					Active dorsiflexion			—	
					At rest			110	
Right				Active plantar-flexion	120				
				Range	10				

which are turned under. 6) Clawed toes, which may result if too strong a pull is given to the toe extensors by suturing these to the mobile section of the active tendino-muscular transfer when there are no muscles to provide flexion of the metatarso-phalangeal joints (Andersen 1961).

PRINCIPLES OF TREATMENT

With these points in mind a new method of foot drop correction has been evolved with the object of: 1) maintaining the muscular support of the talo-navicular joint; 2) providing tendon-to-tendon union to reduce immobilisation to three weeks; 3) leaving the bones of the foot intact; 4) reducing the tendency to dropped toes and clawed toes.

The principle of the modified operation is to leave the distal five centimetres of the tendon of tibialis posterior *in situ* and to attach this stump to the flexor digitorum longus as the two tendons lie together above the medial malleolus. This means that the flexor digitorum longus will pull on the insertion of the tibialis posterior and so maintain some muscular support of the arch of the foot and the talo-navicular joint. Its power of pull on the toe tips is thus reduced, so that dropped toes are not so likely to occur.

The proximal part of the tendon of tibialis posterior is still available for transfer with the muscle belly, but will not of course reach to the dorsum of the foot. To meet this deficiency further variations of technique have been evolved. The tibialis posterior is attached to the tendon of tibialis anterior at the junction of the middle and lowest thirds of the leg and the tibialis anterior tendon therefore prolongs the tendon of tibialis posterior so that it reaches the medial side of the dorsum of the foot. The lateral side of the foot is provided for by a peroneal slip that is woven through the tibialis anterior to form an inverted Y distal to the ankle when the tibialis posterior muscle contracts and dorsiflexes the foot—hence there is no active pull on the toe extensors if they are stitched to this peroneal slip and the effect is that of a tenodesis.

Good results cannot be expected if the ankle will not passively move through an adequate range. It is desirable that after surgery the patient should be able actively to lift the toes off

TABLE I—*continued*
COMPARISON OF THE OLD AND NEW METHODS IN CASES 1 AND 2

Angles after operation in degrees						Comment
3 weeks	7 weeks	4 months	7 months	12 months	20 months	
70	70	65	70	70	73	Walks very well now. Feet previously very unstable and needed crutches to walk at all
80	78	70	78	86	85	
90	85	75	85	90	90	
92	90	95	95	95	100	
12	12	15	17	11	15	
68	70	70	70	70	75	
75	78	82	82	85	90	
80	90	90	90	95	95	
85	95	95	95	100	105	
10	17	13	13	15	15	
75	75	70	70	70	70	Right foot excellent result. Left foot revised in December 1966 at patient's request. Now walks very well
83	83	84	96	90	94	
90	95	95	110	105	105	
95	100	104	115	110	110	
13	17	20	19	20	16	
60	65	65	60	65	70	
73	80	80	80	80	80	
76	88	90	90	90	90	
80	90	95	95	100	100	
7	10	15	15	20	20	

the ground when he is standing with his heel on the ground. A range of 10 degrees of movement on each side of the midpoint of ankle movement is probably ideal but not necessary in practice. To achieve this it is necessary to be able to dorsiflex the ankle passively to 75 degrees with the knee straight; if this is not possible it is advisable to lengthen the calcaneal tendon.

Measurements—All measurements are taken with the knee straight and the leg parallel with the ground, with increasing values as the foot passes from dorsiflexion (extension) to plantar-flexion (flexion). By this method all changes follow a regular transition and one does not need to state if the movement is flexion or extension in each case.

TECHNIQUE

Through an incision on the medial side of the leg the tendons of tibialis posterior and flexor digitorum longus are displayed and the calcaneal tendon is lengthened if necessary. The tendon of tibialis posterior is divided obliquely so that the distal slip can be sutured into the lateral side of the flexor digitorum longus. There should be no tension on the suture when the ankle is dorsiflexed to 80 degrees and the toes are straight.

The anterior surface of the interosseous membrane is displayed at the level of the junction of the middle and lowest thirds of the tibia, through a curved incision based medially, and the membrane is incised along the tibia. The proximal part of the tibialis posterior tendon is pulled through to the front of the leg. Sufficient fibres of the tibialis anterior muscle are separated from its tendon to allow the tendon of the tibialis posterior to be passed through the hole so made so that the two tendons lie side by side and burying of unsatisfied tendon ends is simplified.

A slip is passed from the peroneus tertius or from the insertion of peroneus brevis to the tibialis anterior tendon at the ankle, and sutured to it so that the tibialis anterior tendon is pulled slightly to the lateral side of the mid-point of the ankle (Fig. 1). This slip can be peroneus brevis, peroneus tertius if it is well defined, or a tendon graft. This provides lateral lift and stability. If the foot is very mobile extra slips may be used passing from the tibialis anterior

at the ankle to the periosteum of the fifth metatarsal neck. The further distal the fixation, the less likely is inversion or instability. With the hallux straight the tendon of extensor hallucis longus is sutured without tension to the tibialis anterior tendon, distal to its junction with the peroneal slip. To the peroneal slip the toe extensors are sutured without tension when the toes are straight. This will help to prevent dropped toes.

With the knee held at about 40 degrees of flexion, and the ankle dorsiflexed to 75 degrees, the tendons of posterior and tibialis anterior are then sutured together with the greatest tension possible, and all unsatisfied ends are buried. This position is held during final skin closure and until the plaster-of-Paris cast is applied to maintain position.

FIG. 1

Diagram to show passage of peroneus brevis from its intact insertion, subcutaneously to the tibialis anterior tendon, and then forward to the fifth metatarsal neck.

The plaster is removed after three weeks, with no weight-bearing, and is converted into a backslab to be worn all the time when the patient is not exercising. Active re-education is started as soon as the plaster is removed, and active control is usually achieved within the first week, when partial weight-bearing is allowed until the patient has learnt to use the transferred muscle against gravity, at which time walking is started. The patient is expected to be walking within three weeks of removal of the plaster—that is six weeks after operation. The backslab is discarded by day once walking is well established but is used at night for a further three or four weeks.

SELECTION OF CASES

The first two patients had bilateral foot drop. They had previously had a corrective operation for one foot, using a previous technique. The second foot was done with the new method. In both patients the peroneus brevis was used for the lateral slip, and in both the toes were still fairly mobile. No complications occurred and both patients preferred the "new method" without knowing it was technically different. In Table I the range of movement of both pairs of feet as recorded over a period of twenty months is set out for comparison. It will be noticed that slackening continues to occur over a long period of time for both methods, but that by the end of four months the foot is fairly stable.

These two patients were out of plaster and evaluated before further cases were done by similar methods. Because the first two feet thus treated functioned well it was decided to do

TABLE II
ANGLES OF MOVEMENT IN RECENT CASES

Case number	Sex	Age in years	Follow-up in months	Angles in degrees					Comment
				Passive dorsi-flexion	Active dorsi-flexion	At rest	Active plantar-flexion	Range	
3	Male	25	13	75	88	95	102	14	Very satisfactory. Walks well
4	Male	33	11	73	85	95	100	15	Good walk after tibialis anterior shortened
5	Male	42	10	75	95	100	110	15	Good function. Consideration must be given to loss of great toe
6	Male	46	9	75	88	95	100	12	Very satisfactory with almost normal gait
7	Female	52	9	75	85	90	97	12	Some inversion after initial surgery corrected by tightening of the lateral slip
8	Female	57	9	70	85	97	117	32	Excellent range and a fair gait. Other foot arthrodesed
9	Male	36	9	70	88	95	105	17	Very slow to re-educate. Now walks very well
10	Female	30	9	70	80	90	97	17	Short foot from loss of toes. Walks quite well
11	Male	36	8	70	80	90	105	25	Some lateral instability corrected when peroneus brevis was used to replace peroneus tertius. Now walks well
12	Male	25	6	73	85	95	98	13	Foot very stable. Patient satisfied though only small range of movement
13	Male	33	6	68	80	86	93	13	Foot rather stiff but patient satisfied and walks quite well

all subsequent operations by this method. A total of fifteen more cases were done in the following ten months. The movements found in those with a follow-up of six months or more are given in Table II with comments on function.

DISCUSSION

It is considered that the range of movement achieved by this transfer adequately provides for the function of the foot. Minor variations in the method of stabilisation of the lateral side of the foot were tried but the peroneus brevis has usually proved the most adequate lateral stabiliser.

One case only had increased warmth and slight swelling about two weeks after removal of the plaster. This lasted for two days only and did not recur when walking was resumed. Radiographs taken at least three months after operation in each case have shown no signs of bone breakdown.

The tendency to drop toes is difficult to assess. No patient so far has complained of the development of dropped or clawed toes but a continued watch must be kept for these complications.

There has been no sign of talo-navicular instability in any case. This usually manifests itself within six months of operation. Only time will tell whether the reactivation of the distal

stump of the tibialis posterior tendon does in fact reduce deformity and if the use of the flexor digitorum longus for activation of this stump reduces the incidence of dropped toes and collapse of the long arch of the foot.

It has been found that this procedure is technically easier than other methods and takes less time.

SUMMARY

1. The complications following standard tendon transfer to provide active correction of drop foot in Chinese patients with leprosy are reviewed.
2. An alternative method of foot drop correction is described in which reactivation of the remaining distal stump of the tibialis posterior tendon is provided to assist in maintaining the stability of the arch of the foot and to help to prevent dropped toes.
3. A review of thirteen patients is given. The indications are that this method is functionally as good as other methods. So far it has shown none of the complications usual in Chinese patients.

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