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FOOT DROP IN LEPROSY AND ITS SURGICAL CORRECTION

By

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In the management of preventible and correctible deformities, due to lepra, drop foot occupies an important place. The nature of these two departments have prevented any kind of survey of the total and relative incidence in the various types of lepra. *Hemerijckx* (1959) reported a detailed survey from 8 associated clinics in S. India. He found in a group of 2337 patients 3 cases of bilateral and 59 cases of unilateral drop foot. This is an overall incidence of 2.5 per cent.

The pathology of this deformity has received considerable interest in these departments. The important points in this context will be briefly mentioned. A full discussion of this is outside the scope of this paper. As a rule foot drop is due to paralysis of the lateral popliteal nerve just above the point where it winds round the neck of the fibula. Previously it was thought that sooner or later all the muscles of the anterior and lateral compartments would become paralysed. A certain amount of evidence, admittedly preliminary, is coming forward to suggest that we are dealing with two distinct patterns of paralysis, "complete lateral popliteal paralysis" and "incomplete lateral popliteal paralysis". In the first type all the muscles of the anterior and lateral compartments are paralysed. In the second type only the muscles of the anterior compartment are paralysed. A certain number of cases will present themselves for reconstructive surgery with a "partial pattern of paralysis" with only some of the muscles in these compartments paralysed. We consider that such patterns indicate a process towards one of the stable patterns of paralysis or a recovering paralysis. Another group will present more complex patterns of paralysis, involving some muscles outside the lateral and anterior compartments as

well. These "irregular patterns of paralysis" are considered due to one of the following factors: 1) a concomitant post polio paralysis, 2) a biological variant mainly found in the lepromatous and dimorphous cases with widespread nerve involvement, or 3) a particular site of neural damage with no reference to any pattern as occasionally found in the tuberculoid cases.

Of paramount importance is the fact that in the majority of cases the tibialis posterior muscle is active and suitable for transfer. This is the rationale behind the standardized procedures it has been possible to develop.

It deserves underlining that when a muscle becomes paralysed due to leprosy, and when the pathological process has run its course, the involved muscle is either completely paralysed or completely normal. This is in strict opposition to post polio paralysis.

Possible ways of correcting foot drop.

Foot drop can be corrected in several ways: 1) It has been impossible to find any references in the available literature, but it can be heard expressed off the record that at least in Western women a drop foot need not be corrected since it is so well suited to a high heeled shoe. This is not only too defeatist, but distinctly wrong. 2) The wearing of some mechanical device to maintain the foot in the desired position of dorsiflexion, peroneus straps, spring shoes, etc.. Such devices undoubtedly have their place in the management of extreme paralysis. They may also be of value in cases of partial patterns of paralysis, where it is as yet uncertain what the final pattern of paralysis will be, or where chances of neural recovery are still present. They might be acceptable as permanent fixtures in certain communities, but in the majority of the countries where lepra is prevalent, they are definitely unacceptable for social and economic reasons. 3) Corrective surgery of the skeletal structures of the foot, mainly arthrodesis of the Lambrinudi type. In cases of extreme paralysis this may be the only rational therapy, but it should be considered a last resort for two reasons, it is a major procedure, fraught with danger, esp. in lepra where tarsal disorganisation is a fairly frequent and extremely distressing condition, and the liability of the anterior joint capsule to stretch postoperatively will frequently undo any achievement of the operation, and will indeed leave the foot in a worse condition. 4) Transfer of a suitable muscle to achieve the desired dorsiflexion. As pointed out above the tibialis

posterior muscle is active and suitable for transfer in the majority of cases of paralysis due to lepra. Over a number of years various methods of tibialis posterior transfer have been used in these departments.

This paper will present an evaluation of some of these methods. It will also attempt a comprehensive presentation of the problems involved in foot drop in lepra.

Literature Review.

The use of the tibialis posterior muscle as a dorsiflexor of the foot goes back to *Ober*'s report on 1933. It is now a widely accepted method. In 1956 *Hodges* reported on the use of a Lambrinudi type of triple arthrodesis in 15 cases of foot drop due to lepra. A 4 months follow up showed satisfactory results in all cases. 2 patients seen 15 months after surgery showed good results. Our reasons for not accepting this as a standard procedure have been stated. In 1957 *Fritsche & Brand* reported on the correction of drop foot in lepra using tibialis posterior transfer with a tendon to bone insertion, either via the interosseous or the circumtibial route. They recommended high tension on the transferred muscle with the foot at right angle position with slack tendon in full dorsiflexion. They found the circumtibial route slightly better than the interosseous. Other related techniques were mentioned. A detailed review of clawing of the toes was given. Triple arthrodesis of Ryerson type was recommended for tarsal neuropathy. In 1957 *Gunn & Molesworth* reported on 56 cases of foot drop due to leprosy repaired by tibialis posterior transfer by circumtibial or interosseous route. They demanded as preoperative conditions a complete lateral popliteal paralysis, a reasonable passive dorsiflexion of the ankle, and a strong tibialis posterior muscle. They obtained 49 cases with satisfactory results. They recommended tendon suture with the foot in dorsiflexion. In 1959 *Selvapandian & Brand* gave a preliminary report on 39 cases of foot drop due to leprosy, operated on by tibialis posterior transfer, by circumtibial or interosseous route, with a tendon to bone insertion. Their results corresponded closely with those obtained by *Gunn & Molesworth*. Their findings indicated a definite superiority of the circumtibial route. The biological behaviour of tendon grafts and tendon transfers, and also of the response to surgical trauma have been dealt with recently by *Brand*. The problems of the neurological patterns in leprosy were dealt with by the author in 1961.

Indications for corrective surgery of foot drop in leprosy.

The first point raised above does not enter seriously into our deliberations.

Several attempts have been made to produce a spring shoe that could be made and worn under village conditions. They have not been satisfactory.

The choice therefore rests between correction by arthrodesis and by tendon transfer. Triple arthrodesis of the foot has a very definite place within the reconstructive surgery of the foot as a means of counteracting tarsal neuropathy. But we do not recognize any indication for its use as a means of correcting foot drop when a suitable muscle transfer is possible.

Subject to certain contraindications all cases of foot drop in leprosy can and should be corrected.

Contraindications.

In all cases attention to the whole patient takes preference over any one particular deformity. Therefore surgery should be deferred if there is any danger of detrimental effect on the medical therapy. Arbitrarily we demand that medical therapy must be well established for not less than 3 months prior to surgery. No "lepra reaction" must have been present during the last 3 months. And – as a more controversial point – it is probably wise to defer surgery until the bacteriological index is below 1.0. In actual fact very few cases will be affected by this last rule.

Very little is known about recovery of neural damage in lepra, either spontaneously or consequent to therapy. Preliminary experience from the department of physiotherapy, Schieffelin Leprosy Research Sanatorium, indicates that foot drop in certain cases can recover 8 weeks after onset of paralysis, possibly even after longer intervals. We therefore demand that no patient be operated whose paralysis has shown signs of development, for better or worse, during the last 6 months. This does not mean that these patients should be turned loose with no supervision. A closely supervised programme of physiotherapy and ulcer prevention is very essential in these cases. If properly trained personel and hospital facilities are available these patients should be under institutional care. The various techniques of therapy in these cases are still on the experimental stage.

Since this is elective surgery a high degree of aseptic security should

be demanded. Naturally no septic foci may be present on the actual limb to be operated on. Nor may they have been present for several weeks prior to surgery. The same, although to a less extent, holds true of the patient as a whole. In view of the fact a neuropathic foot often harbours smouldering infection, extreme care is indicated in this respect.

Youth is no contraindication, provided sufficient cooperation can be obtained.

In a department that is loaded with requests for reconstructive surgery, some policy of preference must be formulated. Although the general policy has been, and rightly so that anybody who desires reconstructive surgery, is eligible for it, and that all the patients are operated on in order of arrival at point of readiness, it is a tacit understanding that youngsters with a long life in front of them, and persons where correction of a deformity has a major influence on their job holding capacity, should have preference.

Preoperative assessment.

A full clinical examination of the patient should be done with a view to possible contraindications. The presence of other deformities should be noted. A comprehensive plan of the total programme of reconstructive surgery should be made at an early date.

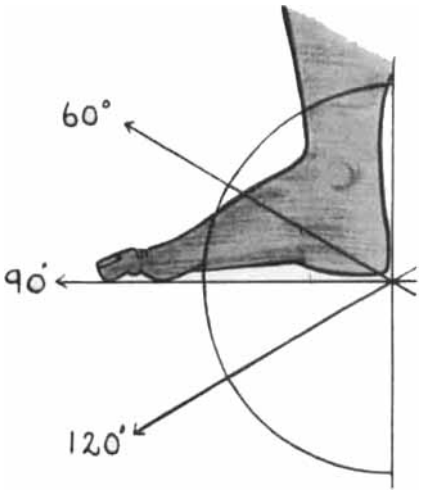

Fig. 1.
shows in diagrammatic outline the terminology of the angles of dorsiflexion and plantar flexion as employed in these departments.

Fig. 2.
Normal.

Fig. 3.
Broomstick Y.

Fig. 4.
Peroneus Y.

Fig. 2. shows in diagrammatic outline the arrangement of the tendons on the front of the ankle in the non-operated, normal foot.

Fig. 3. shows the arrangement of the tendons after a "broomstick Y" method of tibialis posterior transfer.

Fig. 4. shows the arrangement of the tendons after a "peroneus Y" method of tibialis posterior transfer.

The following points should receive particular attention:

1) The pattern of paralysis, esp. the suitability of the tibialis posterior muscle for transfer, and partial patterns of paralysis.

2) Duration of paralysis.

3) Passive mobility of the ankle joint. The drop foot usually assumes an equino-varus position. In a number of cases contracture of the posterior structures supervenes. Although the triceps surae muscle is the chief culprit, all the structures on the posterior aspect of the leg participate. This deformity is better styled "heel cord contracture" than "tendo Achillis contracture". Based on clinical experience the author has defined heel cord contracture as the condition where passive dorsiflexion of the ankle to 70° or less is not possible, keeping the knee straight, and using "no undue force".

4) Skeletal malalignment and tarsal instability. A point that is easily overlooked is the tibial displacement of the subtaloid joint, either as a true angulating varus position or as a parallelaxic displacement with or without angulating varus. A fixed deformity can render an otherwise successful operation valueless. An unstable deformity likewise jeopardizes the result of a tendon transfer. As a rule it is better to correct

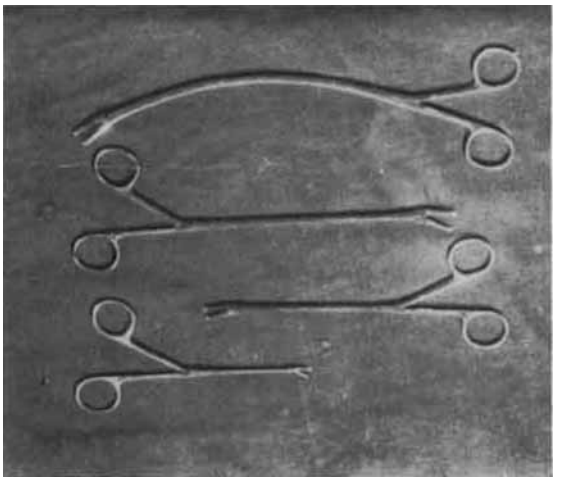

Fig. 5.
shows four varieties of the bluntnosed tendon tunneller designed by the author with open jaws. No. 1 is a curved tunneller, designed for tibialis posterior transfer, total length 35 cm. No. 2 and no. 3 are straight tunnellers, resp. 30 and 20 cm. long. They are particularly useful in tendon transfers round the upper extremity. No. 4 is a slender tendon tunneller, 15 cm. long, particularly useful for tendon transfers round the fingers and the eye.
They are being manufactured by the Indian Sterilizer Company, Madras.

such deformities before tendon transfer is undertaken. Heel cord contracture and claw toes can often be corrected simultaneously with tendon transfer for drop foot.

5) Loss of tissue, either due to true absorbtion or to incidental traumas should be recorded, as should be scarring of the foot. Both may have an important bearing on the choice of method and on the final result.

6) Pathological stiffness of joints, either fibrous or osseous ankylosis, has an important bearing on the final result.

7) Previous surgery may have an important influence on the choice of method and on the final result.

Choice of method.
Certain general points will here be considered.

1) After transfer of the tibialis posterior muscle its tendon must be fixed, either to the skeletal structures on the dorsum of the foot, preferably the middle cuneiform bone, or to the tendons on the extensor

side of the foot. Both methods can produce good results. Clinical experience in these two departments has led us to consider a number of points pro et contra. Unfortunately the available material does not lend itself to a thorough analysis of these points.

In favour of tendon to bone insertion are the following points:

a) The absence of any sutures in the course of the gliding tendon means less chance of adhesions with reduction in active movement.

b) Since only one tendon is transferred, it is a relatively quick method.

Against tendon to bone insertion are the following points:

a) Interference with bone and periosteum will in certain cases produce an unsightly and troublesome swelling.

b) Accidental infection, even of low virulence, may have a disastrous effect on the foot, particularly if it penetrates into bone, which is more likely to occur if the tendon is inserted into an osseous tunnel.

c) Interference with the skeletal structures may trigger off neuropathy of the foot, even in the absence of gross infection.

d) Insertion of a tendon into bone of actually or potentially poor quality may not produce reliable anchorage.

e) The frequently employed pull out wires through the sole of the foot are a source of trouble when fitting shoes. It should be considered an axiom in surgery on anaesthetic feet that no incision may occur on the weight bearing surface.

In favour of tendon to tendon insertion are the following points:

a) Less than perfect balancing of the foot with only one "guy rope", as in transfer of the tibialis posterior tendon to the dorsum of the foot, will tend to produce a progressive, rotatory dorsiflexion with disastrous result to the gait. A tendon to tendon insertion with one guy rope to either side of the foot will be more laterally stable, unless the balancing is so defective that weight bearing forces the foot off balance. In such case it is either a gross error of preoperative assessment or an equally gross technical error.

b) Tendon to tendon insertion to the natural points of insertion might be expected to produce a more physiological function.

c) In the methods of tendon to tendon insertion where one guy rope is inserted proximal to and the other distal to the transtarsal joint, this

BROOMSTICK "Y"
TIBIALIS POSTERIOR TRANSFER—CIRCUMTIBIAL ROUTE

Postoperative Assessment

Position of rest	Mild high stepping	Normal	
70			
70– 80			
80– 90		1	
90–100	1	8	
100–110	2	2	
110–120			
120–			
Total	3	11	(14)

Active Dorsiflexion

70			
70– 80		5	
80– 90	2	3	
90–100	1	3	
100–110			
110–120			
120–			
Total	3	11	(14)

Range

0– 10		1	
10– 20	3	4	
20– 30		4	
30–		2	
Total	3	11	(14)

Postoperative Deformities		*Overall Results*	
Tarsal deformity	1	Excellent	4
Claw toes	2	Good	7
Drop toes	1	Fair	3
		Poor	0

Total no. of cases 14.

PERONEUS "Y"
TIBIALIS POSTERIOR TRANSFER—CIRCUMTIBIAL ROUTE

Postoperative Assessment

Position of rest	Mild high stepping	Normal	
70			
70 - 80			
80– 90		5	
90–100		3	
100–110	2		
110–120			
120 -			
Total	2	8	(10)

Active Dorsiflexion

70		1	
70– 80		6	
80 - 90	1	1	
90 100	1		
100–110			
110–120			
120–			
Total	2	8	(10)

Range

0– 10			
10– 20	1	4	
20– 30	1	3	
30–		1	
Total	2	8	(10)

Postoperative Deformities		*Overall Results*	
Tarsal deformity		Excellent	2
Claw Toes	2	Good	6
Drop Toes	1	Fair	2
		Poor	–

Total no. of cases 10.

TENDON TO BONE
TIBIALIS POSTERIOR TRANSFER—INTEROSSEOUS ROUTE

Postoperative Assessment

Position of rest	High stepping	Mild high stepping	Normal
70			
70– 80			
80– 90			
90–100		3	12
100–110	3	10	6
110–120		2	
120–			
Total	3	15	18 (36)
Active Dorsiflexion			
70			1
70– 80		1	6
80– 90	1	8	6
90–100	1	4	4
100–110	1	2	1
110–120			
120–			
Total	3	15	18 (36)
Range			
0– 10			
10– 20	2	6	1
20– 30		7	13
30–	1	2	4
Total	3	15	18 (36)

Postoperative Deformities		*Overall Results*	
Tarsal deformity	9	Excellent	4
Claw toes	11	Good	18
Drop toes	5	Fair	10
		Poor	4

Total no. of cases 36.

TENDON TO BONE
TIBIALIS POSTERIOR TRANSFER—CIRCUMTIBIAL ROUTE

Postoperative Assessment

Position of rest	High stepping	Mild high stepping	Normal
70			
70– 80			
80– 90			5
90–100		6	17
100–110	1	8	6
110–120	1	3	
120–		1	
Total	2	18	28 (48)
Active Dorsiflexion			
70			
70– 80			8
80– 90		7	19
90–100	1	9	1
100–110		2	
110–120	1		
120–			
Total	2	18	28 (48)
Range			
0– 10			
10– 20	2	3	11
20– 30		13	9
30–		2	8
Total	2	18	28 (48)

Postoperative Deformities		*Overall Results*	
Tarsal deformity	18	Excellent	12
Claw toes	7	Good	19
Drop toes	9	Fair	15
		Poor	2

Total no. of cases 48.

joint might be expected to remain more stable than where the insertions are all proximal to the joint. (This applies mainly to the choice between the "peroneus Y" and the "broomstick Y" methods.)

d) In the methods where the toe extensors are incorporated in the insertion, "drop toes" can be corrected simultaneously.

2) The tendon of the tibialis posterior can be brought to the dorsum of the foot by two routes, the interosseous or the circumtibial route. Both are capable of producing good results, although the author prefers the circumtibial, subcutaneous route, partly because it is technically easier, particularly when a specially designed, bluntnosed tendon tunneller is used, and partly because more adhesions are likely to form when the tendon passes the tough interosseous membrane. In cases where a narrow interosseous space is found the tendon may be strangulated.

3) Attempts have been made to pass the transferred tendons circumtibially, deep to the extensor retinaculum at the ankle in order to avoid troublesome bowstringing. In all cases tough adhesions formed. It should be recorded that bowstringing at the ankle has rarely been a source of trouble in this series.

4) The doctrine of the V. This expression is being introduced to emphasise certain well known, but easily forgotten principles of tendon transfer. A transferred tendon that moves in a straight line or in a smooth, mildly curved line, is more likely to obtain a good gliding function than its opposite number moving in angulating, irregular curves. A transferred tendon moving in a single trune from origin to insertion is superior to a branching tendon. Branching tendon transfers are permissible under the following conditions: The branching must take place in tissue where the formation of gliding mechanism is easily obtained. The angle between the branches must be as acute as possible, (in other words a tendon V is superior to a tendon T.) The point of the V must be proximal, since it otherwise would prevent the active contraction of the motor muscle. Conversely the angle between the branches may be a factor in the early days of reeducation in preventing the strong triceps surae from pulling the weaker and operatively weakened tibialis posterior into an undesired position of plantar flexion. The deviation of the branches from the motor tendon must be identical. Where two or more tendons are joined together, only the active motor tendon should be permitted to continue its course proximal to the junction, since the excursion of the motor tendon otherwise will be hampered by the reserve V. This of course only holds true in the gliding course of a tendon.

5) Tension of the transferred muscle. Accurate grading of the initial and final strength of any transferred muscle is a tricky procedure. The points to consider are: a) The required strength to counteract successfully the newly acquired antagonists which may be stronger than the original ones. b) The original range of the transferred muscle, compared with the ideal range in the new position. c) The physiological loss of strenght of any muscle when transferred as compared with the expected hypertrophy after reeducation. d) The unavoidable loss of strength due to alteration of the angle between the contractile muscle fibres and the transmitting tendon fibres.

Since the desired function is a simple one, clean dorsiflexion at the ankle with the deliberate sacrifice of the more complex pronating-supinating movements, the problem can be simplified to preservation of the greatest possible amount of inherent strength to act in a range and with a placement of the range, where the tibialis posterior in counterbalance with its newly acquired antagonists, the triceps surae and the toe flexors, can be expected to secure adequate, stable dorsiflexion of the foot to allow a normal gait.

The practical consequence of this is that the foot must be placed at an angle of dorsiflexion during operation, and that the transferred tendon must be secured there under high tension. Because of the phenomenon called "drop of range", the transferred tendon must be sutured under high tension at an angle of clean dorsiflexion of the ankle joint, 10 degrees more than the desired postoperative dorsiflexion. In order to allow healing under relaxed conditions the foot is immobilised in plaster of Paris under higher dorsiflexion than for the tendon suture. In the majority of cases the foot can be expected to achieve an active dorsiflexion to 10 degrees short of the position of tendon suture. (Preoperative passive dorsiflexion with straight knee: 65, tendon suture at 70, immobilisation at 65, expected active dorsiflexion 80.) It is not advisable to overdo the dorsiflexion of the ankle joint by passive flexion of the knee. The result will be undue pressure between the food and the plaster cast.

When the plaster cast is removed, the foot will assume an angle of dorsiflexion about 10 degrees below the angle of initial immobilisation. Any movement discernible at that time will be in the nature of active plantar flexion and a passive spring back. As the range improves under physiotherapy the major part will develop from an increased pull of the antagonists and a pull back, increasingly so, by active muscle contraction of the transferred muscle.

If heel cord contracture is present, surgical correction is usually resorted to simultaneously with the foot drop correction. The routine method is a Z plasty of the tendo Achillis. Measurements during actual surgery indicate that the gain is one degree of dorsiflexion for every mm. of lengthening.

Pre- and postoperative physiotherapy.

Selection of the proper method, assessment of expected postoperative results and actual results should be carefully recorded.

Regular preoperative training is essential in order to obtain the best result from any method. Although this is usually carried out in a relatively independent department of physiotherapy, the closest possible cooperation with the surgeon is recommended.

When the decision has been taken that a particular foot is ready for surgery a short period of training is instituted. The essential feature is to call the attention of the patient to the active play of the tibialis posterior muscle, and training in its independent, voluntary function. This is done by placing the patient sitting with the paralysed foot over the opposite knee with the insted pointing up. He is instructed to lift the forefoot. Most patients will quickly learn this. Attention to the skin with oil massage and wax bath has a definite place.

After surgery the patient returns to the ward with the foot in a plaster cast below the knee, incorporating a toe guard. The author prefers to leave the toes open for inspection on the guard. After a few days in bed wih elevated foot a rocking device is incorporated and the patient is ambulated.

Earlier this plaster cast was left intact for 6 weeks. Since the introduction of the tendon to tendon insertion methods it is not considered necessary to immobilise the foot for more than 4 weeks.

At the end of 4 weeks the plaster cast is removed, and the posterior half of the bivalved cast is reapplied as a non weight bearing splint, which is worn constantly outside training periods for the next 10 to 14 days. The sutures are removed, and unless some failure in union is evident, active physiotherapy is instituted. The first phase is active use of the transferred muscle with gravity as an assisting force. This is done by placing the patient on his belly with the knee flexed at right angles. Later active use of the transferred muscle with gravity eliminated is instituted with the patient sitting with the operated leg crossed over the opposite knee. Still later active use against gravity is encou-

raged with the foot hanging down. The final phase is weight bearing exercises, first as rocking and balancing exercises between bars, later as walking between bars, and finally as free walk. The whole time the patient is carefully instructed to use the transferred muscle in its full range, even if he could get by with much less effort. Active plantar flexion is only encouraged in the very last stages when the patient is confident in free walk. Three to four weeks are the usual period of postoperative physiotherapy, after which the patient is discharged with instructions to return later for follow up studies and final evaluation. As the patient gains confidence in the daily use of the transferred muscle, the careful, delibrate overuse is changed into a more normal gait.

Since this work is being done in close cooperation with an ulcer prevention programme, no patient is permitted to walk until suitable, light shoes are available. This, however, is outside the scope of this paper.

This work was started as a pioneer work with no clear concept of all the factors involved. The personel and the methods of record keeping have changed during this period. For these reasons the available data on many of the cases are not complete in view of present understanding of the problems.

The majority of the cases have been operated on by one of four methods: 1) tendon to bone insertion by the interosseous method, 2) tendon to bone insertion by the circumtibial method, 3) tendon to tendon insertion by the circumtibial method ("peroneus Y"), and 4) tendon to tendon insertion by the circumtibial method ("broomstick Y"). A follow up study of these four methods will be presented. Other methods employed have all been used in so small numbers that a statistical analysis is not possible.

Irrespective of the particular method employed, three points should receive attention. A perfectly aseptic technique is imperative. The surgical anaesthesia employed is important, particularly in respect of the tension of the transferred muscle. For more than 12 months a lytic cocktail of chlorpromazine and pethidine has been used routinely. This has been very satisfactory. The tensions mentioned in this paper refer to this method. Careful atraumatic tissue technique is extremely important. This relates not only to handling of the tendons, but also to skin incisions that should not override tendon junctions or the gliding course of the transferred tendons. (*Brand*, 1961).

Tendon to bone insertion methods.

These are well known techniques. The point of insertion is selected to secure a clean dorsiflexion. In most cases the middle cuneiform bone is chosen. A tunnel is prepared into the bone and the tendon is inserted into this. Frequently a pull out wire is used through the sole of the foot.

Thangaraj from Purulia in 1959 reported the use of interosseous transfer of the tibialis posterior to be inserted into the tibialis anterior, the extensor hallucis, and the extensor digitorum longus high in the leg. He achieved good results although only in a small range. This method obviously violates the doctrine of the V. It also invites crippling adhesions to the tough interosseus membrane. Two other tendon to tendon insertion methods were therefore introduced almost simultaneously.

The peroneus Y method

employs a circumtibial, subcutaneous transfer of the tibialis posterior to the insertion of the tibialis anterior. The tendon of the peroneus longus is divided high in the leg and withdrawn to the foot, from where it is transferred subcutaneously across the ankle to be inserted into the tibialis posterior tendon at an acute angle at the point where it winds round the border of the tibia. The foot is placed in dorsiflexion, and the tendons are secured under equal, and high tension. The main advantage of this method is its relative simplicity and the use of good, solid tendons. Its main disadvantage is the lack of tendon insertions distal to the transtarsal joint. When this joint is stabilised with active tendons on the flexor side, and only tenodesis on the extensor side, hypermobiliy and disorganisation may occure here.

The broomstick Y method

was originally introduced by *Verghese & Andersen.* It employed transfer of the tibialis posterior as in the peroneus Y method, but instead of the tendon of the peroneus longus, the extensor digitorum longus was used. The extensor hallucis longus tendon was tenodised to the insertion of the tibialis anterior. This has later been changed by the author to include transfer of both the extensor digitorum longus and the extensor hallucis longus to the point of the transferred tendon of the tibialis posterior where it winds round the border of the tibia. The tendons are secured under equal, high tension with the foot in dorsiflexion. Attempts have been made to include the peroneus longus tendon in

the "broomstick". This has no real advantage. On the other hand it adds one more tendon to be secured under high and accurate tension. The main advantage of this method is the insertion of tendons both distal and proximal to the transtarsal joint, with more stability of this joint. It permits correction of concomitant claw toes. On theoretical grounds it would seem that the better leverage in the broomstick Y method permits better correction of mobile varus-inversion deformities.

Both of these methods employ two guy ropes to stabilise the foot. This calls for meticulos attention to the diversion of the branches from the motor tendon and to the equality of the tension. It will frequently be found advantageous to place the foot in slight valgus-eversion during tendon suture. This will compensate for the inevitable lateral shift of the tendon junction and consequent slackening of the lateral guy rope.

Attempts have been made to avoid incisions on the dorsum of the foot by a circumtibial transfer of the tibialis posterior across the anterior compartment, interweaving on its way with the tendons of the tibialis anterior, extensor hallucis longus, and extensor digitorum longus, all of which are brought forward through windows in the deep fascia. These attempts have failed to produce good results, as is to be expected, since they violate the doctrine of the V, and also employ a motor tendon transferred in an undulating course through tissue with a poor tendency to formation of gliding mechanism.

Postoperative presence of drop toes or claw toes, although they have no direct bearing on the operative method employed, detract from the final result, since they constitute a hazard to the foot.

The available material does not permit a complete evaluation of tarsal deformities. In any case, their presence postoperatively will detract from the final result. Presence of preoperative, fixed tarsal deformities is an indication for triple arthrodesis prior to tendon transfer. Passively reducable, but stable tarsal deformities can be corrected by tendon transfer, provided due attention is paid to correct alignment and tension. Their presence postoperatively is therefore a failure of the surgeon to obtain the best possible result from the employed method. Preoperative, unstable tarsal deformities cannot be expected to be corrected by tendon transfer. They constitute an indication for triple arthrodesis prior to tendon transfer. The present material does not permit a thorough evaluation of these points. It is hoped that this will be possible later.

This material does not permit an analysis of the relation between

preoperative passive dorsiflexion (presence of heel cord contracture) and the achieved postoperative active dorsiflexion. It is hoped that this will be possible later.

A comparison between the two tendon to bone insertion methods indicates a superiority favouring the circumtibial route. This is probably due to crippling adhesions in the interosseous space.

In a few cases the tendon suture was done with the tendon slack with the foot in dorsiflexion. The results are reflected in the few cases of postoperative highstepping gait found in the tendon to bone insertion methods.

The author's contention that the tendon suture must be performed under 10 degrees more dorsiflexion than the expected active postoperative dorsiflexion is based on a series of cases that have not been included in the present study.

The material does not permit a study of the relation between tendon to bone insertion and tarsal neuropathy. It has been found in some cases, but no analysis will be attempted.

The position of rest seems to have some influence on the gait. It should be 90 degrees or less in order to secure an easy gait with no high stepping as the foot is carried forward. The angle of active dorsiflexion seems to have greater influence on the gait. It must be less than 90 degrees in order to secure a normal gait. In a few cases normal gait has been recorded in the presence of insufficient active dorsiflexion. These cases all belong to the early group. It is reasonable to suggest that the criteria for grading the postoperative results have become stricter over the years. It is tempting to attempt correction for this discrepancy. It has, however, not been done. Since all the oldest cases belong to the tendon to bone insertion methods, this theoretical correction would tend to emphasise the superiority of the tendon to tendon insertion methods.

The range of active movement from extreme dorsiflexion to extreme plantar flexion will be found expressed in the active range. A high range does not seem to have any influence on the gait, provided the range has the correct placement.

The number of cases on record does not permit any definite evaluation between the tendon to bone insertion methods and the tendon to tendon insertions methods. There appears to be some tendency towards better results from the tendon to tendon insertion methods. The small material does suggest a slight superiority of the broomstick Y method over the peroneus Y method.

SUMMARY

The author presents a study of 108 cases of drop foot in leprosy operated by tibialis posterior transfer. Four distinctive variations of this method are described, including two previously undescribed methods of tendon to tendon insertion. A review of the problems relative to foot drop in leprosy is presented.

ZUSAMMENFASSUNG

Der Verfasser berichtet über eine Untersuchung von 108 Fällen von Lepra-Fallfuss, die mittels Transplantation des m. tibialis posterior behandelt wurden. Vier unterschiedliche Variationen dieser Methode, einschliesslich zweier vorher nicht veröffentlichter Methoden der Vereinigung von Sehne zu Sehne, werden beschreiben.

RESUME

L'auteur présente l'étude de 108 cas de « drop foot » chez des lépreux opérés par transfert du jambier postérieur. Quatre variations distinctes de cette méthode sont décrites, y compris deux méhodes d'insertion de tendon à tendon qui n'ont pas été décrites auparavant. Les problèmes relatifs au « drop foot » de la lèpre sont passés en revue.

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