Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 11, 2023

Evaluation of outcomes of different methods of tibialis posterior transfer for foot drop correction in Hansen's patients

Dr. Kaushik Paul[1*]

[1*]Assistant Professor, Department of General Surgery, I.Q. City Medical College, Durgapur, West Bengal, India

***Corresponding author:** Dr. Kaushik Paul
*Assistant Professor, Department of General Surgery, I.Q. City Medical College, Durgapur, West Bengal, India

Abstract
Introduction: Common peroneal nerve palsy resulting in foot drop is common in Hansen's patients. Dynamic reconstruction involving tibialis posterior tendon transfer is considered as gold standard for restoration of normal toe-heel gait.
Materials and methods: The operations were performed via interosseous and circumtibial routes for tibialis posterior transfer and outcomes were systematically analyzed.
Results: Both the procedures resulted significant functional benefits and prevented development of complications.
Conclusion: Removal of tibialis posterior tendon does not cause any deficit. The favourable results following surgical intervention are sustained in the long term. Additional Tendoachilles lengthening provided better results in selected patients.

Keywords: interosseous route, circumtibial route, tibialis posterior tendon, tendon transfer, foot drop

Introduction

Loss of common peroneal function leading to paralysis of the anterior and lateral compartment muscle groups in the leg is common in leprosy. The resulting foot drop leads to an abnormal compensatory high stepping gait and risk of ulceration to the lateral forefoot if there is concurrent sensory loss to the sole of the foot. Therefore, if surgery is available, it is considered first treatment option to prevent development of secondary deformities and ulceration. The main purpose of corrective foot surgery is to restore normal gait. The common peroneal nerve injury resulting in foot drop occurs due to various causes [1]. Apart from Hansen's disease other common cause of common peroneal nerve injury is trauma [2]. It results in loss of dorsiflexion, ankle eversion, and toes extension. The intact tibialis posterior may develop equinovarus deformity [3]. Permanent foot drop in spite of development of microsurgery [1].

The objective of reconstruction is to restore normal toe-heel gait [1,4]. Tenodesis, arthrodesis, and tendon transfers are the various static and dynamic options for correction of foot drop [5]. The gold standard for correction of foot drop are the dynamic procedures [6]. It restores near-normal functional activity, and also prevents the equinovarus deformity caused by the TP tendon [7].
For tendon attachment either tendon-to-bone fixation i.e. looping the tibialis posterior tendon around the second metatarsal (a modification of classic Barr's procedure) [8] may be used, or TP tendon may be attached to the tibialis anterior tendon, EHL and EDL tendons.
The present study evaluates the results of tibialis posterior transfer via either the interosseous (IO) or circumtibial (CT) approach. Patients will be assessed based on parameters of pre and post operative active and passive movements of the foot and post operative complications. The objective outcome of the study will be done by criteria described by Carayon et al. [9].
Materials and methods

STUDY AREA:

R. G. Kar Medical College and Hospital, Kolkata
The Leprosy Mission Hospital (Premananda Memorial Leprosy Hospital), Kolkata

STUDY POPULATION:

Inclusion Criteria –
1) Following preoperative physiotherapy a minimum of 10 degrees of dorsiflexion from neutral with knee flexed.
2) Dorsiflexor or eversion weakness MRC 0-2.
3) Able to mobilize with crutches or a walking frame.
4) Medical therapy well established for a period not less than three months prior to surgery.

Exclusion Criteria-
1) Evidence of active neuropathic bone disintegration for a minimum of three months following the completion of trial walking.
2) Unable to look after skin of affected limb.
3) Paralysis shows signs of development, better or worse, during the last 6 months.
4) Septic foci on the actual limb to be operated on.

STUDY PERIOD:

O1. 01. 2012 to 15. 12. 2013.

SAMPLE SIZE:

Thirty cases**.**

SAMPLE DESIGN:

Leprosy patients with foot drop as per inclusion and exclusion criteria.

STUDY DESIGN*:* -

Phase I: -
1) Extensive literature survey and review of available techniques carried out at R.G. Kar Medical College and Hospital, Kolkata and The Leprosy Mission, Kolkata.
2) To take approval of The Ethical Committee at R.G. Kar medical College and hospital, Kolkata and The Leprosy Mission, Kolkata.
3) Screening and enlistment of patients who were operated previously and who will be operated.

Phase II: -
1) Admission of patients as per criteria and their enlistment and operation.
2) Periodic examination of post operative cases, according to protocol

Phase III: -
1) Analysis of results, as per protocol, and necessary modifications, if needed, in design, composition, processing, operative techniques, pre and post operative protocols will be adopted.

Phase IV: -
1) Completion of study and preparation of detailed study report

2) Analysis of report and making a project completion of report.
3) Identification of future research scopes in the area and the preparation for future research projects.

PARAMETERS TO BE STUDIED:

Preoperative deformities
Functional assessment of foot
Post surgical complications

PREOPERATIVE PHYSIOTHERAPY:

Pre-operative physiotherapy focuses on teaching the patient to learn isolated contraction of the tibialis posterior muscle. This is achieved by exercise with resistance to foot inversion in a crossed leg sitting position for three to four sessions in a day. The patient is taught self stretching exercises of the tendo-achilles to release the contracture as much as possible.

OPERATIVE TECHNIQUES:

Achilles Tendon Lengthening (TAL):

Closed technique: Closed technique consists of a sliding lengthening. Under anaesthetic with the knee straight and the foot held in forced dorsiflexion resting on the surgeon's hip a Percutaneous Achilles tendon lengthening is made. Using a size 11 or 15 blade a stab incision is made in the distal medial half of the tendon 1 cm above its insertion into the calcaneum. A second proximal lateral stab incision is made at the musculo- tendinous junction. With continued forced dorsiflexion the fibres of the Achilles tendon are allowed to slide. This results in a passive dorsiflexion of at least 30 to 40 degrees from neutral. The tendon is palpated externally to ensure continuity proximally and distally. The principle of this procedure is to allow a slide of the fibres within the tendon sheath without complete rupture of the tendon.

Open technique: When there remains posterior capsular tightening after exercises or maximum length needs to be ensured, then a standard open Z-lengthening can be performed.

Careful placement of a concave curved incision posterior medial above the medial malleolus can allow both access to the Achilles tendon and retrieval of tibialis posterior for tendon transfer. As per the closed technique after opening the tendon sheath the Achilles tendon is divided through half its bulk both proximal lateral and distal-medial and then split down its length. The two ends are then sutured side to side for one to three cms

TECHNIQUE OF TIBIALIS POSTERIOR TRANSFER:

Interosseous route:
Under spinal or general anaesthetic the patient is placed in a supine position and an above knee tourniquet is applied. An Achilles tendon lengthening procedure is first performed. If an open lengthening is done then the same incision can be extended, curved proximally and medially to allow for both delivery of the tibialis posterior tendon, and access to the interosseous space.

An 8 cm curved or straight incision is made starting one to two finger breadths proximal to the medial malleolus in the line of the tendon. The tibialis posterior tendon is exposed lying deep to the tendon of flexor digitorum longus. Care is taken not to damage the long saphenous vein or the saphenous nerve. A skin crease incision is made just proximal to the tibialis posterior insertion to the navicular on the anterior-medial aspect of the ankle. At this level it is easily palpable. The tendon insertion is exposed

and an artery forceps placed across the tendon with the foot adducted. The correct tendon is confirmed by pulling on it above the malleolus.

The tendon is then divided at its insertion, freeing both superficial and deep attachments to maintain length. In the incision proximal to the medial malleolus, a digit or blunt instrument is placed under the tibialis posterior tendon just distal to the musculo- tendinous junction and the tendon is delivered into the wound. It is important to try and avoid stripping the distal muscle fibres directly off the tendon. By blunt dissection the tibialis posterior tendon and its muscle unit is stripped off its origin from the tibia in the middle third of the calf, mobilising the complete unit. The adequacy of the interosseous space can often be determined at this stage. An eight cm longitudinal incision is made over the anterior aspect of tibialis anterior 1-cm posterior to the prominence of the anterior tibial border in the distal half of the middle third of the calf. Using a pair of long dissecting scissors a complete fasciotomy is performed. By blunt dissection and a right-angled retractor the muscle of tibialis anterior is retracted to expose the interosseous membrane. Care is needed not to tear the deep veins as haemostasis is difficult and subsequent bleeding can lead to adhesions as the tendon passes through the interosseous space. A small incision is made in the membrane, and this is extended by blunt dissection as far proximal as possible. At this stage it is important to confirm the suitability of the interosseous space for the transfer. The space narrows distally and can sometimes be irregular on its tibial surface.

The tip of a little finger should pass easily through this space. Some authors advocate a pre operative X-ray of this space as a guide, but this has not been standardised. Should there be excess irregularity or the space very narrow then the interosseous approach should be changed to a circumtibial at this stage.

A large curved Anderson tendon tunneler is passed through the interosseous space and around the posterior aspect of the tibia. The tibialis posterior tendon is then brought into the anterior compartment and under tibialis anterior to lie lateral to it. This decreases the possibility of adherence between the raw muscle fibres of tibialis posterior and the surface of the tibia.

At this stage it is useful to check that there is sufficient length to reach the tendons over the anterior aspect of the ankle. If insufficient length is present then further stripping of the muscle of tibialis posterior from its bony origin may be required. The wounds on the medial aspect of the leg are irrigated and closed.

Transverse skin crease incisions are made over the distal portion of the anterior aspect of the ankle after palpating the tendons. A number of options of insertion exist. In most cases a two-slip tendon to tendon anastomosis, the medial slip to TA and EHL with the lateral slip to EDC and PT.
A subcutaneous tunnel is made superficial to the extensor retinaculum using long blunt tendon tunnellers.
With the knee flexed the ankle is held in at least 20 degrees dorsiflexion, (by an assistant or using a Fritschi splint) the tendons are anastomozed using a double weave technique.

Following the operation, the ankle should be kept at least 20 degrees dorsiflexion. The foot should also be in neutral or mild eversion. If the position is not satisfactory then the slips should be adjusted on the table.

Circumtibial route: The principle of the circumtibial approach is the same as the interosseous except the tibialis posterior tendon doesn't pass through the interosseous canal into the anterior compartment. It is critically important to maximise vertically the angle the tendon takes into the foot to mechanically mimic the action of the anterior group of muscles. The operation proceeds as per interosseous approach with an Achilles tendon lengthening and the Tibialis Posterior tendon released from its insertion to the navicular. Incisions and stripping of the Tibialis Posterior are as described for the interosseous approach, except that the lateral calf incision is not used.

A subcutaneous tunnel around the anterio-medial aspect of the lower tibia is made, superficial to tibialis anterior and the extensor retinaculum to the dorsum of the ankle. This must reach the midline at least 5 cm above the ankle to ensure a good angle of pull. The tendon is then split into two slips and passed separately or split after passing to the ankle. The procedure then continues as per interosseous route.

Clinical Photographs

Figure1

Figure2

Figure1: TPT (IO ROUE): RIGHT FOOT DROP BEFORE OPERATION
Figure2: TPT (IO ROUTE): INCISIONS TO RETRIEVE TP FROM ITS SITE OF INSERTION

Figure3

Figure4

Figure3: TPT (IO ROUE): IDENTIFICATION OF TP
Figure4: TPT (IO ROUTE): DISSECTION TO IDENTIFY INTEROSSEOUS MEMBRANE

Figure5

Figure6

Figure5: TPT (IO ROUTE): BEFORE TAKING OUT OF TP VIA INTEROSSEOUS MEMBRANE
Figure6: TPT (IO ROUTE): AFTER TP WAS TAKEN OUT VIA INTEROSSEOUS MEMBRANE

Figure7

Figure8

Figure7: TPT (IO ROUTE): TP WAS DIVIDED INTO THREE SLIPS

Figure8: TPT (IO ROUTE): TENDON TUNNELER WAS BEING USED TO RETRIVE DIVIDE SLIPS OF TP

Figure9

Figure10

Figure9: TPT (IO ROUTE): POSITION OF THE FOOT DURING ANASTOMOSIS

Figure10: TPT (IO ROUTE): ANASTOMOSIS BEWEEN EHL AND ONE DIVIDED SLIPS OF TP

Figure11

Figure12

Figure11: TPT (IO ROUTE) POSITION OF THE FOOT AFTER CLOSURE OF INCISION LINES

Figure12: TPT (CT ROUTE): TP IS TAKEN OUT VIA CT ROUTE

Figure13

Figure14

Figure13: TPT (CT ROUTE): AFTER OPERATION

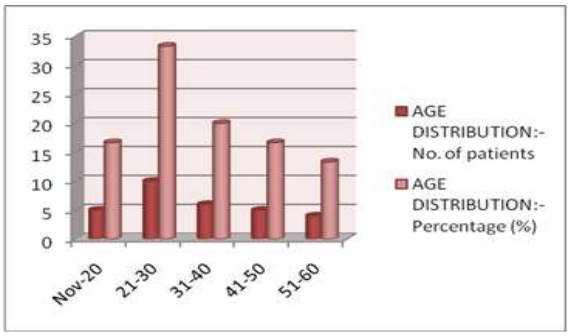
Figure14: TPT (CT ROUTE): DEMONSTRATION OF TA, EHL & EDL; TP BEFORE DIVISION

Figure15 Figure16

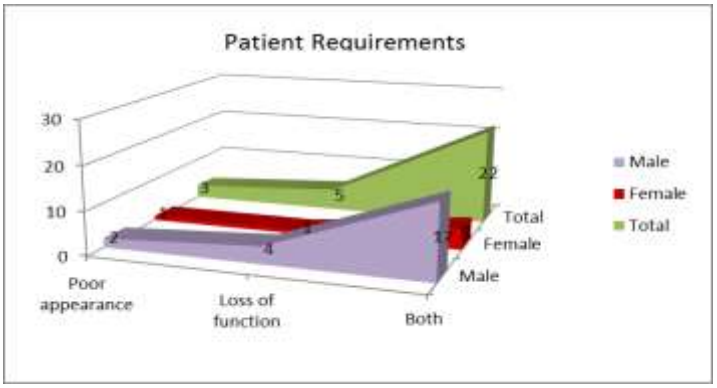
Figure15: TPT (CT ROUTE): DEMONSTRATION OF TA AND EHL
Figure16: POSITION OF THE FOOT AFTER OPERATION

Results

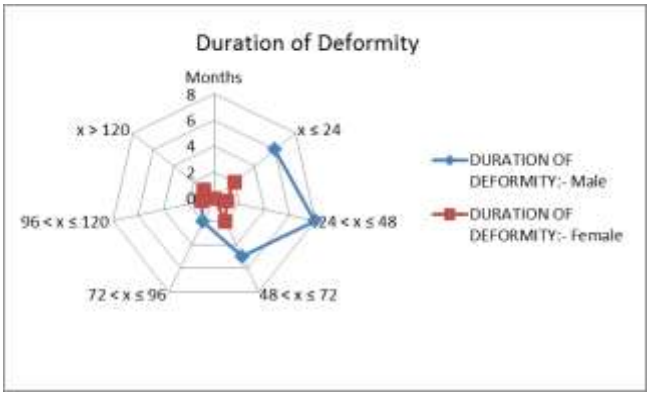
There were 44 cases of foot drop, in Leprosy patients, operated at R. G. Kar Medical College and Hospital, Kolkata and Premananda Memorial Leprosy Hospital, Kolkata between 1st January, 2012 and 15th December, 2013.
Only 30 cases out of these 44 cases, which fulfilled the inclusion criteria, were included in this study.



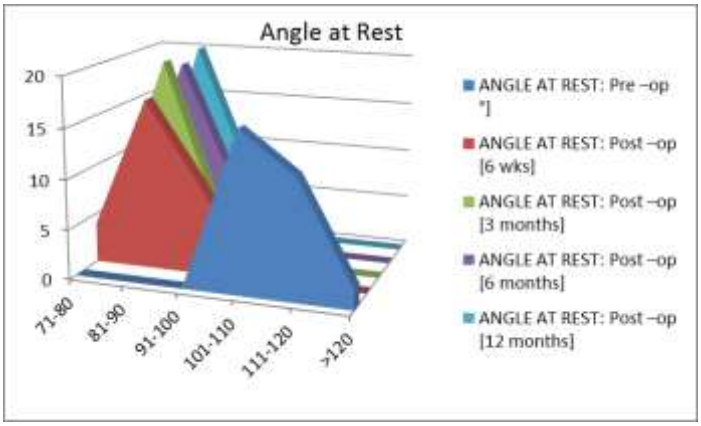
Age range of patients enrolled in this study was 14 yrs to 57 yrs. The peak incidence was noted in the 3rd decade of life, closely followed by the 4th decade of life.
Male: Female Ratio- 3.285: 1
Out of the 30 cases operated, 5 patients were suffering from bilateral disease. In these cases, only one side was operated at a time, and the preference was left to the choice of the patient.



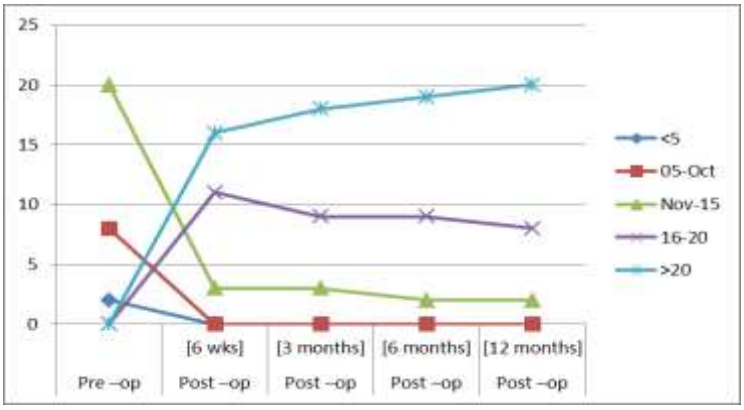
Most of the patients in this study (73.33 %) presented with complaints of both poor appearance and loss of function. However, 16.67 % (4 male and 1 female) patients presented with only loss of function and 10% (2 male and 1 female) presented with only poor appearance.



The mean duration of deformity in this study was 46.58 months, with a range of 7 to 144 months. The mean duration was 44.58 months for males and 53.71 months for females.
In most patients, tibialis posterior transfer was done via interosseous route (70%) although the selection of patients was based on the preference of the surgeon.
In our study Tendoachilles lengthening was done in 83.33% patients. With TA lengthening active dorsiflexion beyond 15 degrees after 12 months was found in 96% patients in comparison to 80% patients without TA lengthening.



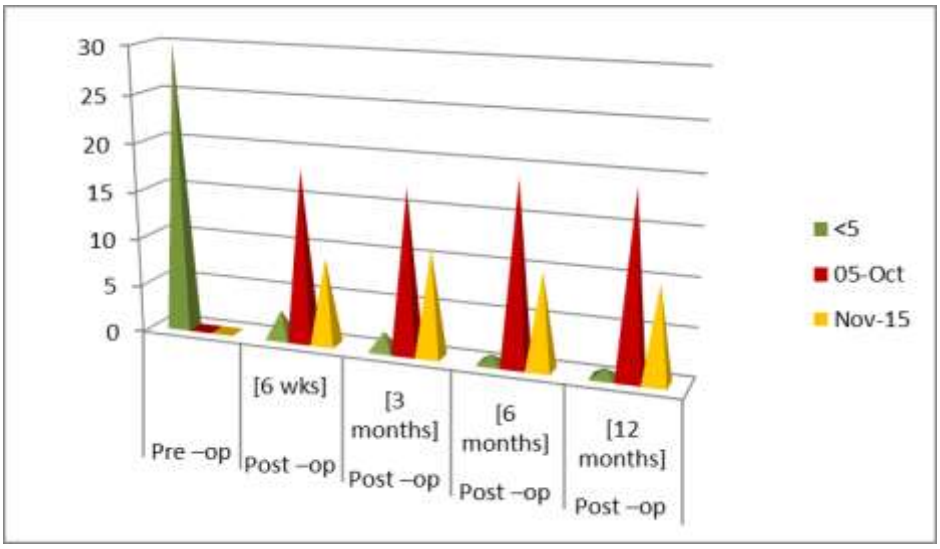
In most of the patients the angle at rest before operation following physiotherapy was in the range of 101-120 degrees (93.33%). After 12 month follow up 66.67% patients achieved angle at rest in the range of 81-90 degrees. The minimum angle of rest found in this study was 80 degree.
The improvement in the angle at rest in the range of 81-90 degrees occurred in 44.44% patients (76.19% patients via interosseous route) whereas in another 44.44% patients it improved upto the range of 91-100 degrees (14.28% patients via interosseous route).



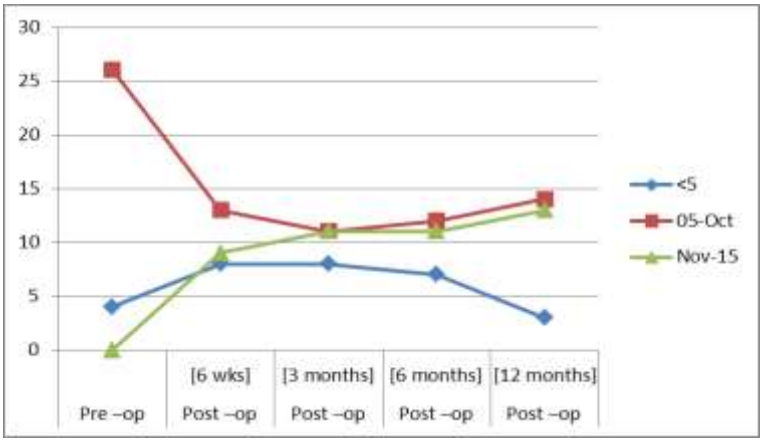
Before operation active dorsiflexion with knee flexed in the range of 10-15 degrees was in 66.67% patients. Following operation after 12 months of post op follow up it was found that in 66.67% patients

the range of active dorsiflexion was > 20 degrees. In 26.67% patients it was in the range of 16-20 degrees.

Following IO transfer with knee flexed in 71.42% patients it was found that the active dorsiflexion was more than 20 degrees after 12 months follow up whereas in 23.80% patients it was in the range of 16-20 degrees.
With the knee flexed the active dorsiflexion improved beyond 20 degrees in 55.55% patients (71.42% via interosseous route) after 12 months follow up. In 33.33% patients the active dorsiflexion was in the range of 16-20 degrees (23.80% via interosseous route).

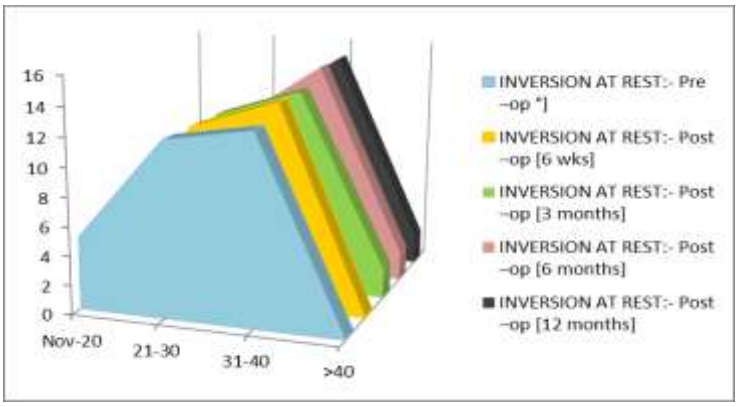


When the knee was kept in straight position the active dorsiflexion in the range of 5-10 degrees was possible in 63.33% patients 12 months following the operation. In another 33.33% patients active dorsiflexion beyond 10 degrees was possible.
In 86.62% patients the passive dorsiflexion was in the range of 41-60 degrees. Following operation it reduced to <20 degrees in 63.33% patients after 12 months of follow up and it was in the range of 21-30 degrees in another 33.33% patients.
Before operation passive dorsiflexion beyond 20 degrees was possible in 83.33% patients. Following operation after 12 month the passive dorsiflexion in range of 11-15 degrees was possible in 40% patients. In another 50% patients passive dorsiflexion was possible in the range of 5-10 degrees.
The active planter flexion in knee flexed position was in the range of 11-15 degrees in 13.33% patients before operation which was seen in only 3.33% patients following operation after 12 months. In 50% patients <5 degrees of active planter flexion were possible 12 months following the operation.



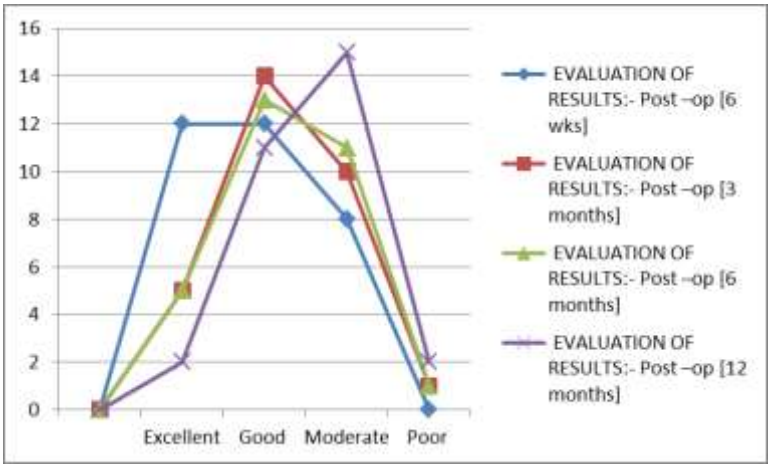
Twelve months after operation in 13 (43.33%) patients passive planter flexion in the range of 11-15 degrees was possible whereas in another 46.67% patients it was possible in the range of 5-10 degrees. In none of the patients the passive planter flexion beyond 10 degrees was possible.

When the knee was kept in flexed position passive planter flexion in the range of 5-10 degrees was possible in 46.67% patients after 12 months of surgery. In another 26.67% patients it was possible in the range of 11-15 degrees



Inversion at rest beyond 40^0 was detected in 2 (6.67%) patients after 3 months follow up. After 6 months it was in the range of 31-40 degrees in most of the patients (50%).

In 93.33% patients the normal heel to toe gait developed 12 months after operation. Rest of the patients developed high steppage gait.
After 12 months 96.67% patients were able to walk normally.
After 12 months 66.67% patients can squat normally.
In our study no complication was seen in 76.19% patients with interosseous transfer and 66.66% patients with circumtibial transfer. In the first post-operative follow up pain (16.67%), swelling (16.67%) and infection (10%) were detected as early complications which were resolved subsequently with conservative management. Inversion (22.22%) and eversion (11.11%) deformity were found exclusively in circumtibial group whereas secondary claw toe deformities were detected in 14.28% patients in interosseous group and 11.11% patients in circumtibial group after 3 months following surgery.



Following the Carayon's evaluation criteria excellent and poor results were obtained in 6.67% patients after 12 months follow up. In most patients moderate (50%) to good (36.67%) results were found.

Discussion

For restoration of normal toe-heel gait a significant proportion of patients require tendon transfer[10]. Watkins et al., Codivilla [11], and Putti [12] are considered as the pioneers of the tibialis posterior tendon transfer to the dorsum of the foot through the interosseous route [13]. The major drawback of the technique is the length of the transposed tibialis posterior tendon which was insufficient preventing tendon-to-bone fixation [13,14]. Barr et al inserted the tendon to the intermediate or lateral cuneiform or base of 2nd metatarsal bone through the interosseous route [15]. Ober inserted the tendon to the base of the 3rd metatarsal through the circumtibial route [16]. Stable fixation by pull-out wire, staples, screws, or bone anchors were used for tendon to bone insertion [17]. Tendon-to-tendon fixation has been described as an alternative to tendon-to-bone transfer [18]. Balanced dorsiflexion can't be achieved with direct tenton to tendon insertion because the foot is pulled medially when the anterior tibialis tendon is used as a recipient [9,10,12].The study included 30 leprosy patients (male: female=3.285:1) suffering from foot drop operated between 1st January, 2012 and 15th December. 2013 with a minimum follow up period of 12 months.

The mean age was 30.97 years for male and 28.43 years for female.

The peak incidence was noted in the third decade of life with the age range of 14 to 57 years.

Tibialis posterior tendon transfer was performed via IO route in 70% patients (via CT in 30% patients). In 83.33% patients TA lengthening was done additionally.

The angle at rest improved significantly in 90% patients following the operation and improvement in the angle at rest in the range of 81-90 degrees occurred in 76.19% patients with IO route transfer (44.44% via CT route); 12 months after operation.

The range of active dorsiflexion in knee flexed position was more than 20 degrees in 66.76% patients (71.42% via IO route and 55.55% via CT route); 12 months after operation.

With knee flexed position the active planter flexion was <10 degrees in most of the patients (96.67%).

In 93.33% patients the normal heel to toe gait develop 12 months after operation. Rest of the patients develop high stepage gait.

After 12 months 96.67% patients were able to walk normally whereas normal squatting was possible in 66.67% patients.

In our study no complication was seen in 76.19% patients with IO transfer and 66.66% patients with CT transfer.

Inversion (22.22%) and eversion (11.11%) deformities were found exclusively in CT group. Whereas, secondary claw toe deformity was detected in 14.28% patients in IO group and 11.11% patients in CT group (3 months after surgery).

Following Carayon's evaluation criteria excellent results were obtained in 2 (6.67%) patients. In another 2 (6.67%) patients the results were poor. Good (36.67%) to moderate (50%) results were obtained in most patients.

Conclusions

The usefulness of tibialis posterior transfer as a method of correction of foot drop in leprosy is well known. Removal of tibialis posterior tendon, a deforming force (invertor) in the presence of paralysis of common peroneal nerve, does not cause any deficit. In this study the gains of normal gait, favourable foot at rest position and active range of movement in the dorsiflexion range seen initially are sustained in the long term. Better results can be obtained with additional Tendoachilles lengthening. The interosseous group fared better because of a favourable foot at rest position and a good dorsiflexion range of movement in most of its patients. Circumtibial transfer is associated with increased chances of inversion deformity. It should be reserved for patients with a calcified and unyielding interosseous membrane; these are usually elderly with recurrent inflammation and infection in the foot.

The author has declared that no competing interests exist.

Human Ethics
Consent was obtained or waived by all participants in this study. Ethical Review Committee, R. G. Kar Medical College and Hospital, Kolkata

Animal Ethics
Animal subjects: The author has confirmed that this study did not involve animal subjects or tissue.

References

1. Tibialis posterior tendon transfer for persistent drop foot after peroneal nerve repair. Ozkan T, Tuncer S, Ozturk K, Aydin A, Ozkan S. *J Reconstr Microsurg.* 2009;25:157–164. [PubMed] [Google Scholar]

2. Outcomes of the bridle procedure for the treatment of foot drop. Johnson JE, Paxton ES, Lippe J, et al. *Foot Ankle Int.* 2015;36:1287–1296. [PMC free article] [PubMed] [Google Scholar]

3. Superficial versus deep transfer of the posterior tibialis tendon. D'Astous JL, MacWilliams BA, Kim SJ, Bachus KN. *J Pediatr Orthop.* 2005;25:245–248. [PubMed] [Google Scholar]

4. Double tendon transfer for correction of drop-foot. Grauwin MY, Wavreille G, Fontaine C. *Orthop Traumatol Surg Res.* 2015;101:115–118. [PubMed] [Google Scholar]

5. Posterior tibial tendon transfer for drop-foot. 20 cases followed for 1-5 years. Hove LM, Nilsen PT. *Acta Orthop Scand.* 1998;69:608–610. [PubMed] [Google Scholar]

6. New tendon transfer for correction of drop-foot in common peroneal nerve palsy. Vigasio A, Marcoccio I. *Techn Foot Ankle Surg.* 2008;11:140–149. [Google Scholar]

7. Surgical restoration of drop foot deformity with tibialis posterior tendon transfer. Ozkan T, Tuncer S, Ozturk K, Aydin A, Ozkan S. https://dergipark.org.tr/en/download/article-file/170240. *Acta Orthop Traumatol Turc.* 2007;41:259–265. [PubMed] [Google Scholar]

8. Tendon transfers in traumatic foot. Hahn SB, Kim SS. *Yonsei Med J.* 1991;32:342–346. [PubMed] [Google Scholar]

9. Dual transfer of the posterior tibial and flexor digitorum longus tendons for drop foot. Report of thirty-one cases, Carayon A, Bourrel P, Bourges M, Touze M. https://journals.lww.com/jbjsjournal/ zAbstract/1967/49010/Dual_Transfer_of_the_Posterior_Tibial_and_Flexor.13.aspx *J Bone Jt Surg.* 1967;49:144–148. [PubMed] [Google Scholar]

10. Long-term results of tibialis posterior tendon transfer for drop-foot. Yeap JS, Birch R, Singh D. https://link.springer.com/article/10.1007%2Fs002640100229. *Int Orthop.* 2001;25:114–118. [PMC free article] [PubMed] [Google Scholar]

11. On tendon transplants in orthopedic practice [in Italian] Codivilla A. *Arch Ortop.* 1899;16:225–250. [Google Scholar]

12. The physiological method of tendon transplantation in the treatment of paralytic drop-foot. Mayer L. https://journals.lww.com/jbjsjournal/Abstract/1937/19020/THE_PHYSIOLOGICAL_METHOD_OF_TENDON_TRANSPLANTATION.11.aspx *J Bone Joint Surg.* 1937;19:389–394. [Google Scholar]

13. Transplantation of the posterior tibial tendon. Watkins MB, Jones JB, Ryder CT, Brown TH. https://pubmed.ncbi.nlm.nih.gov/13211711/ *J Bone Joint Surg Am.* 1954;36-A:1181–1189. [PubMed] [Google Scholar]

14. Anterior transplantation of the posterior tibial tendon for persistent palsy of the common peroneal nerve. Lipscomb PR, Sanchez JJ. https://journals.lww.com/jbjsjournal/ Abstract/1961/ 43010/ Anterior_Transplantation_of_the_Posterior_Tibial.3.aspx *J Bone Jt Surg Am.* 1961;43:60–66. [Google Scholar]

15. Calandruccio RA. *Operative Orthopedics.* p. St Louis, Mo: CV Mosby; 1987. Arthroplasty of hip. In: Campbell's Operative Orthopedics, 7th Ed; p. 0. [Google Scholar]

16. Tendon transplantation in the lower extremity. Ober FR. *N Engl J Med.* 1933;209:52–59. [Google Scholar]

17. Tendon transfers in foot drop. Krishnamurthy S, Ibrahim M. *Indian J Plast Surg.* 2019;52:100–108. [PMC free article] [PubMed] [Google Scholar]

18. Split posterior tibial tendon transfer through the interosseus membrane in spastic equinovarus deformity. Mulier T, Moens P, Molenaers G, Spaepen D, Dereymaeker G, Fabry G. *Foot Ankle Int.* 1995;16:754–759. [PubMed] [Google Scholar]