



Outcomes of bilateral two-tailed tibialis posterior tendon transfer for the correction of foot drop

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ABSTRACT

Foot drop is a frequent condition in our society with different etiologies. Many persons plagued by this condition ultimately require treatment to repair the malformation and reduce their impairment (1). (2) The transfer of the tibialis posterior tendon for treatment of foot-drop deformity is widely recognized and routinely performed by orthopedic surgeons; (3) however, most procedures involve transferring the tendon dorsally to a tarsal bone, necessitating the use of an interference screw (4). This technique exploits a two-tailed tibialis posterior tendon-to-tendon transfer, thereby overcoming the disadvantages associated with bony anchoring points.

Objective of the Study: This prospective study aims to assess the functional outcomes of a two-tailed tibialis posterior tendon transfer.

Patients and Methods: This study comprises 25 participants with a total of 25 feet. 17 patients were male, and 8 were female. The participants' ages ranged from 11 to 35 years. All patients were examined using the Stanmore system questionnaire prior to surgery. The surgical method comprises complete transfer of the tibialis posterior, bisecting it into two pieces, with each half subcutaneously isolated. The medial tail is sutured to the tibialis anterior and extensor hallucis longus, whereas the lateral tail is sutured to the extensor digitorum and peroneus tertius. The result was evaluated using the Stanmore system 6 months post-surgery.

Results: 15 feet scored an amazing score, 7 feet earned a good outcome, 2 patients obtained a mediocre performance, and 1 patient had a terrible result. The average degree of dorsiflexion was 5. The average postoperative total score was 78.5. A considerable correlation was discovered between preoperative tibialis posterior muscle strength and the postoperative degree of dorsiflexion as well as the total score attained. No notable link appears between the etiology of foot drop and the overall post-operative score.

Conclusion: In cases of foot drop, the tibialis posterior displays efficient dorsiflexion when shifted anteriorly, provided the muscle has a strength grade of 4 or higher. Suturing the transferred tendon to the extensor tendon of the foot was proved to be a feasible alternative to the typical bony fixation point. The integration of the tibialis anterior and peroneus tertius, with the extensor hallucis longus and extensor digitorum as attachment sites, can enhance dorsiflexion and improve balance against inversion deformity.

KEYWORDS: Foot Drop; Tibialis Posterior; Tendon Transfer.

Compilation of Abbreviations

EDL	Extensor Digitorum Longus
EHL	Extensor Hallucis Longus
EMG	Electromyography
FDL	Flexor Digitorum Longus
MRC	Medical Research Council
MTU	Motor Tendon Unit
NCS	Nerve Conduction Study

PT	Peroneus Tertius
SS	Stanmore System
TP	Tibialis Posterior

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INTRODUCTION

A prolonged injury to the common peroneal or anterior compartment muscles causes foot drop, which is defined by an inability to dorsiflex the foot, evert, and extend the toes. The most injured nerve in the lower extremities is the common peroneal nerve(5)

Etiology

The reasons of foot drop can be roughly categorised into neurologic, muscular, and anatomic categories(6). Among the former are idiopathic, direct trauma along the course of the nerve, injury or surgery surrounding the knee joint, compression from a tumor of the fibula, or a nerve tumor, poliomyelitis, cerebral palsy, stroke, multiple sclerosis, diabetic neuropathy, lumbar disc prolapse, leprosy, Charcot-Marie-Tooth disease, and other conditions. (7)

Tendon Transfers

The principles of tendon transfers should begin with a grasp of tendon architecture and function. The ankle and subtalar joints are predominantly surrounded by the tibialis anterior, tibialis posterior, Achilles, and peroneal longus tendons (8). The strength and excursion of the muscle being replaced should be assessed when contemplating tendon transplant. An additional issue to examine is whether a tendon is phasic or non-phasic. It is realistic to predict that the muscle will experience a drop in strength when a tendon is moved. For tendons in phase with the tendon they replace, muscle reeducation and rehabilitation are hastened, and these tendons retain more strength. (9)

Patient and method

Study design

At a Ghazi alharery teaching hospital specializing in surgery, a descriptive case series was conducted.

Sample technique

25 patients and 25 feet were included in this experiment. The foot decrease was sustained by all patients for diverse causes.

Pre-operative Patient Assessment

History

Full history taken from patients, including patient age, occupation, chief complaint, the duration of foot drop, history of present illness regarding the foot drop, including the onset, the progression, and details of the trauma if present. History regarding conservative therapy trial and its duration, physiotherapy, the need for splint commitment, and details of any previous surgical intervention pertaining to the foot drop.

Examination

The patients' high-stepping stride and general condition were complimented. Examination of the lower extremities utilising both active and passive procedures. Detect any tendon contracture or joint rigidity.

Requesting that the patient dorsiflex the ankle and stretch the toes while sat on the bedside with both legs dangling down, the tibialis anterior is examined by instructing the patient to invert and dorsiflex their foot while keeping a seated position.

tibialis posterior power is evaluated while the patient remains seated on the bedside, and is directed to invert the foot with the hip externally rotated and cross the leg over to the opposite side. The modified British Medical Research Council motor evaluation score is used to grade muscle power, with a grade of at least 4 showing movement against gravity and moderate resistance (10,11).

Investigations

To exclude instances with skeletal abnormalities, radiographs of the foot and limb are conducted. Electromyography and nerve conduction examinations are undertaken to validate the presence of a common peroneal nerve injury, an intact tibial nerve, or a functioning Tibialis posterior muscle.

Inclusion criteria

Irreversible common peroneal nerve lesion that has persisted for more than one year and has not responded to therapy or surgical intervention, and an undamaged tibial nerve.

A power grade of at least 4 for the tibialis posterior muscle.

Adaptable ankle joint

Exclusion criteria

Injury to the sciatic nerve that hits the tibial division
 Rigid ankle and foot deformity, as it demands bony correction
 Foot decrease owing to gradual neuromuscular illness, as the condition is unpredictable. Weak tibialis posterior of grade 3 or lower.
 Previous failed transplantation of the tibialis posterior tendon
 The older patient is satisfied with splint use, as they have experienced foot drop.
 To prevent soft tissue healing issues in diabetic individuals, specific precautions are required.
 An acute peroneal nerve damage that remains untreated can lead to significant problems
 Following completion of the patient assessment and conclusion that the patient is a suitable candidate for the transfer procedure, researchers delivered the Stanmore system questionnaire.

Evaluation Method

Seven categories comprise the Stanmore scoring system (Table 2.1). Each category is assigned a unique score. Muscle power and dorsiflexion degree are scored on a scale of 0 to 25 for each. The following items indicate discomfort and the necessity of orthotics, with scores ranging from 0 to 15. A score of 0 to 6 is assigned for the patient's functional outcome regarding daily activity and recreation restrictions, with 6 indicating no restrictions. Scores ranging from 85 to 100 yield an exceptional outcome. A satisfactory outcome is achieved for individuals aged 70 to 84. A fair outcome is conferred to patients with scores between 55 and 69, while those with scores of 54 or lower are considered to have achieved a poor outcome.

Table 2.1: The Stanmore system questionnaire(12).

Name	Modified Stanmore System Questionnaire	Points
Pain (15 points)	No pain at any time	15
	Mild Pain	10
	Moderate pain	05
	Severe	00
Need for orthoses (15 points)	No	15
	Occasionally (once a week)	10
	Frequently (twice a week)	05
	Regularly (more than twice weekly)	00
Normal shoes (5 points)	Yes	05
	Yes, but prefer a certain type	03
	No	00
Functional Outcome (10 points)	Normal daily activity and normal recreation	06
	Normal daily activity and limited recreation	03
	Limited daily activity and recreation	00
Muscle power (25 points)	Grade 4+ or 5	25
	Grade 4	20
	Grade 3	10
	Grade 2 or fewer	00
Degrees of active dorsiflexion	Greater than 6	25
	0 to 5	20
	-5 to -1	10
	-10 to -6	05
	less than -11	00
Foot posture (5 points)	Plantigrade, balanced, no deformity	05
	Plantigrade mild deformity	03
	Obvious deformity or malalignment	00
Total score of SS		

Muscle power was assessed according to the modified British Medical Research council motor grading score (4) Table 2.2.

Table 2.2: Modified British Medical Research Council motor grading score(13).

Grade	Muscle Power
Grade 5	Muscle contracts normally against full resistance
Grade 4	Muscle strength is reduced, but muscle contraction can still move the joint against resistance
Grade 3	Muscle strength is further reduced such that the joint can be moved against gravity and with resistance completely removed
Grade 2	Muscle can move if the resistance of gravity is removed

Grade 1	Only a trace or flicker of movement is seen or felt in the muscle
Grade 0	No movement is observed

Surgical technique

Surgical site

The appropriate surgical site is verified, marked, and shaven.



Figure 2.1: Direct incision over tibialis posterior insertion.

Operation: The typical 2-3cm incision between the Navicular and the apex of the medial malleolus is used to determine the insertion point of the tibialis posterior tendon (14) (Figure 2.1). To keep the tendon's identity, it is wrapped in a coil (Figure 2.2). A second incision is conducted roughly 10 cm from the medial malleolus. The deep fascia was incised. The flexor digitorum longus is identified.



Figure 2.2: Tibialis posterior tendon is isolated.



Figure 2.3: Incision over the TP musculotendinous junction.

and retracted posteriorly. The tibialis posterior musculotendinous junction is visible immediately beneath the latter. The tendon is verified by drawing on it proximally and observing it slide distally near the insertion. Figure 2.3. After the tendon is liberated from its insertion, it is retrieved proximally using an instrument.



Figure 2.4: elongation of the tendo Achilles.

The degree of ankle dorsiflexion is examined to ensure that a 20-degree angle is attained without excessive tension (Figure 2.4).[\(15\)](#)

Subsequently, the insertion location is prepped. The medial insertion is put across the tendon of extensor hallucis longus & tibialis anterior tendon, while the lateral tail is fixed to extensor digitorum longus and peroneus tertius (16). For each site, a longitudinal curving incision is made approximately 4 cm distal to the line uniting the malleoli (14). The medial incision, dissection, and preventive measures to prevent vascular injury during the healing of the extensor hallucis longus and Tibialis anterior tendons Figures 2.5 and 2.6.



Figure 2.5: medial longitudinal curved incision over the EHL & TA tendons



Figure 2.6: Lateral longitudinal curved incisions over ED & PT tendons.

For each of the two transferred tails of tibialis posterior tendon a separate, subcutaneous circumtibial passage superficial to the extensor retinaculum, tunnels are constructed and tracked to both the medial and lateral attachment site.

A subcutaneous tunnel is made separately for each of the two tails using a sponge. While tunneling both tails to their insertion site, it must be ensured that both tails are gliding freely subcutaneously and are not tethered to a deep structure. Figure 2.7



Figure 2.7: A subcutaneous tunnel is prepared for each of the two divisions of the TP tendon.

The tendon is then separated into two equal tails. To achieve an equal division, a two-stay suture is put to the distal end of the tendon, one on each side of its end. Gentle traction is provided to each stay suture while executing a longitudinal cut down the tendon, commencing from the distal end between the two stay sutures and carrying it proximally to the musculotendinous junction, Figure 2.8. Those stay sutures will also assist draw the two divisions through their tunnels. Figure 2.9. After the medial tail is pulled out to the dorsum of the foot through the medial incision, the foot is held in maximum dorsiflexion, which is roughly 10 °(17). The foot would be held in this position for the rest of the operation Traction is applied to both the medial tail and the Tibialis



Figure 2.8: tibialis posterior tendon is divided into two equal halves.



Figure 2.9: Each tendon is passed subcutaneously to its fixation site.

anterior and extensor hallucis to achieve proper tendon tension, Figure 2.10. The medial tail passed between the tibialis anterior and the extensor hallucis and a minimum of four separate stitches joining the tendons using a non-absorbable size 0 or 1 suture while keeping the tendon under generous tension.

Then, moving to the lateral insertion site, dissection is carried out to reveal the extensor digitorum longus and the peroneus tertius. Including the Peroneus tertius



Figure 2.10: Suturing medial tail to EHL & TA tendon while the foot 20° of Dorsiflexion

Peroneus tertius is crucial in order to balance the foot against the inversion-deforming stress. The suturing procedure is carried out in the same way as on flexion. At least four separated sutures attach the tendons together at multiple sites, the tendon of the Tibialis posterior being between the tendons of the peroneus tertius and the tendon of the Tibialis posterior being positioned between the tendons of the Peroneus tertius and the Extensor digitorum longus (Figure 2.11).

The applied dorsiflexion force is released, and the final ankle position is evaluated, which should be at least 10° of dorsiflexion. Skin closure is achieved, and dressing is placed.

A full above-knee cast is put with the foot at 20 ° dorsiflexion, Figure 2.12.



Figure 2.11: Suturing the lateral tail to ED & PT the foot in 20° of dorsiflexion



Figure 2.12: Wound closure with the final position of the foot before and after casting.

Instructions to the ward to keep the leg elevated and watch for vascularity and compartment syndrome overnight.

Postoperative follow-up

The full non-weight-bearing above knee cast is applied for three weeks after which the cast is bivalved and wound healing and soft tissue status are assessed. The patient is taught dorsiflexion with the foot splinted to prevent any unconscious plantar flexion attempt. The non-weight-bearing below-knee cast is continued for additional 3 weeks. After completion of weeks, the cast is removed, and the patient is kept in an ankle-foot orthosis, which is removed only during physiotherapy sessions, during which plantar flexion is prevented by keeping the foot splinted. After completing 8 weeks, the patient is urged to continue walking with a foot splint for another 2 weeks.

After completing an average of 10 weeks, the patient can walk without a splint. After 6 months following the surgery, the Stanmore system questionnaire was administered again.

RESULTS

25 patients were enrolled in this study with a total of 25 feet: 14 on the right side and 11 affecting the left side. The common peroneal nerve was injured in four patients. Three of them were injured due to a bullet injury around the knee, while the other one was injured due to a road accident affecting the knee and injuring the common peroneal nerve. All patients with bullet injury were males aged between 25 and 35 years old.

In one patient in our study, lumbar disc prolapse was the cause of foot drop. however, the root damage has become irreversible. According to the Stanmore scoring system, 15 out of 25 feet scored a very good result; 7 feet had a good outcome, 2 had a fair outcome, and one was considered to have a poor result.

Of the 25 patients who participated in this study, all required ankle-foot orthoses to assist with gait before the procedure. 22 patients were able to walk without ankle-foot orthosis, partially relieving the requirement for orthosis use.

While all 24 patients returned to normal daily activity postoperatively, 5 of 22 have limited recreation. Although none of the involved feet scored muscle power greater than four, most of the patients were able to dorsiflex their feet against gravity, and all of those patients with strong preoperative tibialis posterior power achieved a grade four

Equinus foot posture in 24 out of 25 feet was corrected to plantigrade balance, with no deformity, and the patient with the lowest Stanmore score improved from severe to mild deformity.

The average postoperative dorsiflexion for the enrolled patients is 5°. 12 patients achieved more than 6°, while only one of the 25 feet involved had less than -1° dorsiflexion.

The mean age of the studied patients was 19.9±9.15 years (range between 1135 years)

Table 3.1 shows a significant positive correlation between postoperative score and post-operative dorsiflexion, r = 0.840, p-value = 0.002, post-operative

ROM, R = 0.674, p-value = 0.033, TP preoperative power, r=0.813, p-value = 0.004, and muscle power (r = 0.833, p-value = 0.003).

Significant positive correlation between post-operation dorsiflexion and TP power preoperative (r = 0.645, p-value = 0.044).

Table 3.1: correlations between studied variables using Spearmans correlation test.

		Post Op. Score	Post-op. dorsiflex-ion	Post op. ROM	TP Power Pre-op	Muscle Power
Pre-op Score	Ts	.153	.196	-.198	.482	-.254
	P value	.673	.587	.584	.159	.480
Post-op score	Ts	1	0	.674	.813	.833
	P value		.002	.033	.004	.003
Post-op dorsiflexion	Ts		1	.630	.645	.516
	P value			.051	.044	.126
Post-op ROM	Ts			1	.488	.586
	P value				.153	.075
TP power pre-op	Ts				10	10
	P value				1	.500
	Ts					.141

Table 3.2 shows no significant differences between preoperative and postoperative score according to the laterality of the lesion independent two-sample t-test, p value>0.05 in both conditions.

Table 3.2. Significance of differences between preoperative and postoperative scores according to laterality of the lesion.

	Site	N	Mean	Std. Deviation	P value
Pre-op score	Right	11	16.50	3.109	0.452
	Left	14	18.67	4.803	
Post-op score	Right	11	77.25	10.56	0.824
	Left	14	79.33	16.78	

Mann-Whitney test, p-value>0.05 in all conditions.

Table 3.3 shows that there were no significant differences between medians of postoperative dorsiflexion, postoperative range of motion, preoperative TP power, and muscle power according to the laterality of the lesion using

Table 3.3: Significance of differences between measured variables according to laterality of the lesion using the Mann-Whitney test.

	Site	N	Median	Mean Rank	P value
Post op dorsiflexion	Right	11	5	5.00	0.792
	Left	14	5	5.83	
Post op ROM	Right	11	22.5	5.25	0.914
	Left	14	25	5.50	
TP power pre-op	Right	11	5	5.25	0.914
	Left	14	5	5.67	
Muscle Power	Right	11	3.5	5.50	1
	Left	14	3.5	5.50	

DISCUSSION

Foot drop is a prevalent condition in current society, with a wide range of etiologies. More than half of the foot drops operated on were traumatic in origin. This was evident in being involved in an accident-causing severe nerve injury. In this investigation, no significant link was identified between a specific etiology of foot drop and the outcome of tendon transfer. Limitations of the Tibialis posterior transfer include the comparatively modest size of the muscle that is destined to carry the demanding weight of the foot against gravity(16). Secondly, the transfer results in a reduction in the transferred muscle power (16). Finally, the excursion of the tendon is less than that of the tendons it is going to replace.(18)

The aforementioned restriction of Tibialis posterior transfer was noticed in this study as none of the patients who received this surgery were able to recover grade 5 muscular power on the modified British Medical Research council motor grading score. (16)

Despite the aforementioned constraints, this study indicates significant improvement in patient functional capacity, as indicated by the extraordinary jump in the average Stanmore score before and after surgery.

This study illustrates that, to a certain extent, a similar outcome was achieved using a more practical, easier tendon-to-tendon transfer technique compared with the classical tendon-to-bone technique.

The tendon-to-bone technique requires a complete set of specifically designed instruments, including a cannulated drill bit, a tendon passer, and an interference screw.

The surgical approach utilized in this study comprises separating the Tibialis posterior into two parts, passing each half via separate subcutaneous tunnels, and suturing the medial half to EHL and Tibialis anterior, and the lateral half to ED and PT.

Involving the TA is believed to give a better fixation point and greater pull of dorsiflexion (19), whereas incorporating the PT would balance the foot against the inversion deformity. Inclusion of EHL and ED in the insertion site would rectify the toe drop that is not addressed, or even aggravated, by tendon-to-bone methods

Splitting the tendon into two parts would minimise inversion or eversion deformity that would arise when a single insertion point is employed, as it bears the potential to modify the direction of pull more medially or laterally leading in inversion or eversion foot posture

In this study, the range is from (-5 to 10). 24 out of 25 feet reached a 5-degree dorsiflexion. The patient with the least dorsiflexion degree has had neglected foot drop for 4 years, with relatively weak TP and severe ankle equinovarus contracture before surgery, and did not adhere properly to physiotherapy and Tibialis posterior re-education exercises.

While 15 of the patients who attained more than 6 degrees of dorsiflexion had a strong Tibialis posterior of grade 5 preoperatively and dedicated adequately to post-operative physiotherapy sessions, despite having varied causes of foot drop.

The route of transfer of posterior can be controversial. It is either the transmembranous or circumtibial routes.(21)

Conducted the extramembranous route 15 patient study with excellent results in 60% of the cases, good and fair is 36%, and poor in 4% only.(17)

In this study, the circumtibial route was utilized, and by splitting the tendon in two equal parts, each with a subcutaneous tunnel, the prominence appearing due to the bowstring effect, resulting from transferring the tendon a single unit subcutaneously, is reduced, causing a better cosmetic effect and lessening effect, resulting from transferring the tendon as a single unit subcutaneously, is reduced, causing a better cosmetic effect and lessening the discomfort of rubbing against shoe wear. The results are expressed as the percentage of patients with satisfactory and excellent results (as determined by the necessity for orthoses, foot posture, degree of dorsiflexion, and muscle strength).

A physiotherapy program aimed at strengthening the tibialis posterior and increasing ankle range of motion directly influences postoperative dorsiflexion range and power(4,23).

It was also found that patients who achieved more than good results had different etiologies for foot drop; however, they shared a well-functioning tibialis posterior preoperatively.

Limitations of the study

1. Limited number of cases.
2. Short length of follow-up.

CONCLUSIONS

- Regardless of the approach chosen, tibialis posterior tendon transfer looks to be a profitable intervention.
- When considering TP transfer, we should be concerned about preoperative muscular power rather than the choice of procedure.
- The etiology of foot drop does not appear to affect the result following the transfer, as long as the tibialis posterior power grade is at least 4.
- Fixating the tendon transferred to the extensor tendons of the foot rather than to the tarsal bone is gaining widespread acceptability due to comparable outcomes (2,20).
- Preoperative tibialis posterior training for at least 2 months, including ankle range-of-motion exercises, was observed to improve postoperative outcomes (25,26).
- Post-operative retraining should not be delayed. Early attempt to execute dorsiflexion is suggested from the third to fourth week, while preserving the back splint to prevent unintended plantar flexion

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