

ORIGINAL ARTICLE

Modified bridle versus bridle tendon transfer procedures for the treatment of foot drop.

Humaira Mushtaq¹, Atta-ul-haq², Muhammad Nasrullah³, Muhammad Faisal⁴

ABSTRACT... Objective: TO compare modification of Bridle procedure in with standard Bridle procedure to ascertain the comparative efficacy. **Study Design:** Quasi-experimental study. **Setting:** Jinnah Burn and Reconstructive Centre (JBRSC) Lahore. **Period:** 1st October 2024 to 30th April 2025. **Methods:** On a total of 70 patients after consent, the patients were divided into two groups: Group A had Modified Bridle procedure as tendon of tibialis posterior (TP) was anastomosed to the extensor hallucis longus as well as extensor digitorum longus above the retinaculum and a slip was Pulvertaft to tibialis anterior below the retinaculum. Group B underwent standard Bridle procedure. Patient satisfaction, dorsiflexion and hammer toe deformity were assessed after which analysis was done using Statistical Package of Social Sciences (SPSS) version 25. P-value less than 0.05 was considered statistically significant. **Results:** Both groups were comparable at baseline (age, sex, side, cause of foot drop, hammer-toe), supporting a fair outcome comparison. The modified Bridle showed a clear shift toward better dorsiflexion grades (Excellent/Good 85.7% vs 60.0%), with the overall test narrowly missing significance (p-value=0.051), suggesting a strong favorable trend. Patient satisfaction was higher with the modified procedure (85.7% vs 57.1%; p-value=0.042). Overall, results indicate that the modified Bridle yields better patient-reported outcomes, with a near-significant advantage in functional dorsiflexion. **Conclusion:** This modification of Bridle procedure improves the outcome of patients with foot drop helping them in this severely debilitating disease in terms of improved dorsiflexion, better patient satisfaction and very few chances of hammer-toe deformity in comparison to standard Bridle procedure.

Key words: Bridle Procedure, Foot Drop, Modified Bridle Procedure, Tibialis Posterior Tendon.

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INTRODUCTION

The term foot drop is defined as an incapacity to raise the forefoot resulting from a weak dorsiflexors. Foot drop may occur due to a problem in the muscles, bones, or the nervous system. The injury of the motor paths causing foot drop may occur centrally or peripherally at several levels.¹ These injuries include damage to or tumors of the common peroneal nerve and sciatic nerve, prolapses of lumbar disc, compartment syndrome or vascular injuries involving the anterior leg compartment, fractures of the tibia and fibula associated with leg compartment syndrome and crush injuries of the dorsum of ankle. The causes known to cause foot drop include fall, sports and recreational activities, motor vehicle accidents, knee replacement surgeries, tumors, cysts, gunshot wounds, and stab wounds.²

The clinical features of foot drop include a high

steppage gait which helps to clear the ground during the swing phase of gait cycle. Hence, this awkward gait results in greater energy consumption, more chances of injury to the forefoot, and risk of falls during walking.³ The identification of cause of foot drop is very crucial as all foot drop patients are not candidates for tibialis posterior transfer. Like lumbar disc prolapse is treated by decompression of the nerve roots while compression by tumour is best treated by removal of tumor.⁴⁻⁷ The patients suffering from foot drop may need braces or surgical treatment to treat the physical dysfunction. The surgical treatment include tendon transfers to restore a near-normal gait.⁸

Mayer first described the transfer of TP through the inter-osseous route. This procedure is taken as the standard for surgical management of foot drop. Several other techniques have been reported for tendon transfers.⁹

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The transfer of tendon allow near-normal functioning of patients with foot drop by restoring the dorsiflexion of the foot.¹⁰ The Bridle procedure uses the tri-tendon anastomosis utilizing the tibialis posterior, peroneus longus and tibialis anterior tendons. The tibialis posterior tendon is transferred through the interosseus route followed by peroneus longus and both are anastomosed to tibialis anterior, all anchored in bone. According to Flynn et al eight patients (100% of those who followed up) dorsiflexed after surgery past neutral position as well as none needed a brace. Johnson et al found that all patients who underwent Bridle procedure had excellent to good outcomes.¹¹

We operated the patients of foot drop with a modification in the Bridle procedure. We made two slips of tibialis posterior tendon and anastomosed one slip to extensor digitorum longus and extensor hallucis longus above extensor retinaculum and other one with tibialis anterior below the retinaculum. We observed good outcome of these patients in form of patient satisfaction, improved dorsiflexion as well as absence of hammer-toe deformity. The literature is deficient regarding not only this modification but also the comparison of both these techniques of tendon transfers. Hence, we present this study to add to national and international data.

METHODS

This quasi-experimental study was conducted at the Jinnah Burn and Reconstructive Surgery Centre in Lahore over six months-time duration from 1st October 2024 to 30th April 2025 after approval from ethical committee (4351/ED/JB&RSC). Convenience sampling was used to select patients. Sample size of 70 patients (35 in each group) was calculated with 2% level of significance, 80% power of study and by taking expected percentage of excellent to good outcome with modified bridle procedure and bridle procedure as 75.67%¹² and 100% respectively.¹³

All patients were informed regarding the procedure and consent was taken. The patients who were included in the study were of all ages, both genders and suffered from foot drop for a period of at least 6 months. The patients who had contracture of Achilles tendon, ankle and toes were stiff or ankle joint

was unstable, gastrocnemius was weak, muscles of posterior compartment of leg were paralyzed and those patients whose foot drop resulted from prolapse of disc or brain disease were not included in the study.

The complete history of patients was taken followed by clinical examination including musculoskeletal and neurological assessment. On local examination, it was confirmed that ankle joint had adequate movement, plantar flexion was present and there was no contracture of the Achilles tendon. All routine pre-operative investigations were done for all patients including radiographs of the ankle and foot, electromyography, as well as nerve conduction studies of the affected lower limbs. The patients were subjected to physiotherapy as well as strengthening exercises for the separated use of tendon of tibialis posterior for six weeks before surgery. Also, Achilles tendon stretching exercises were instituted. The patients were divided into two groups: Group A underwent modified Bridle procedure while group B underwent Bridle procedure.

Surgical Technique

The patients were operated under spinal anesthesia. Tourniquet was applied in all patients prior to operating to limit blood loss. All the surgeries were performed by a consultant plastic surgeon. In group A, about 2 cm incision was given at the level of tuberosity of navicular bone. About 5-7 cm long incision was given: ending about 2 cm above medial malleolus located along the posteromedial palpable border of the distal part of tibia. The tendon of tibialis posterior was harvested. After harvesting the tendon was split into two parts. Another 4 cm long incision was given above the extensor retinaculum exposing all the extensor tendons named the tibialis anterior (TA), extensor hallucis longus (EHL), extensor digitorum longus (EDL), and peroneus tertius (PT) tendons. The tendon was delivered into this incision to bring to anterior compartment through interosseous route. The smooth and frictionless glide of the tendons after transfer was ensured by adequate tunnels. One slip of tibialis posterior tendon was Pulvertaft weaved using prolene 2/0 to the TA tendon below the extensor retinaculum while the other slip to the tendons of EDL as well as EHL above the extensor retinaculum. The ankle was

maintained in 20-30° dorsiflexion. Proline 4/0 was used to close skin incisions in interrupted sutures. Standard wound care was given postoperatively. The skin stitched were removed at 3 weeks. Below knee back slab was used to protect the tendon transfers post-operatively for six weeks. Ankle foot orthosis was worn for the next 6 weeks in a neutral position. Physiotherapy with active dorsiflexion of the ankle was also started. The patients were advised not to put foot in plantar flexion during this phase. Full weight bearing was initiated at three months.

In group B, an incision of 3-4 cm was given above the navicular to expose the tibialis posterior tendon. The tendon was removed from the navicular. The freed tendon was passed proximally and through the posterior malleolus. Another incision was made just anterior to the fibula. Kocher clamp was used to take the tendon anteriorly. The tendon was taken to

the anterior compartment with the help of a Kocher clamp. The tendon of tibialis posterior was passed through tibialis anterior tendon. Another incision was made in the middle part of dorsum of the foot. The tibialis posterior tendon was then fixed to the middle cuneiform in knee flexion of 30° and ankle flexion of 90°.

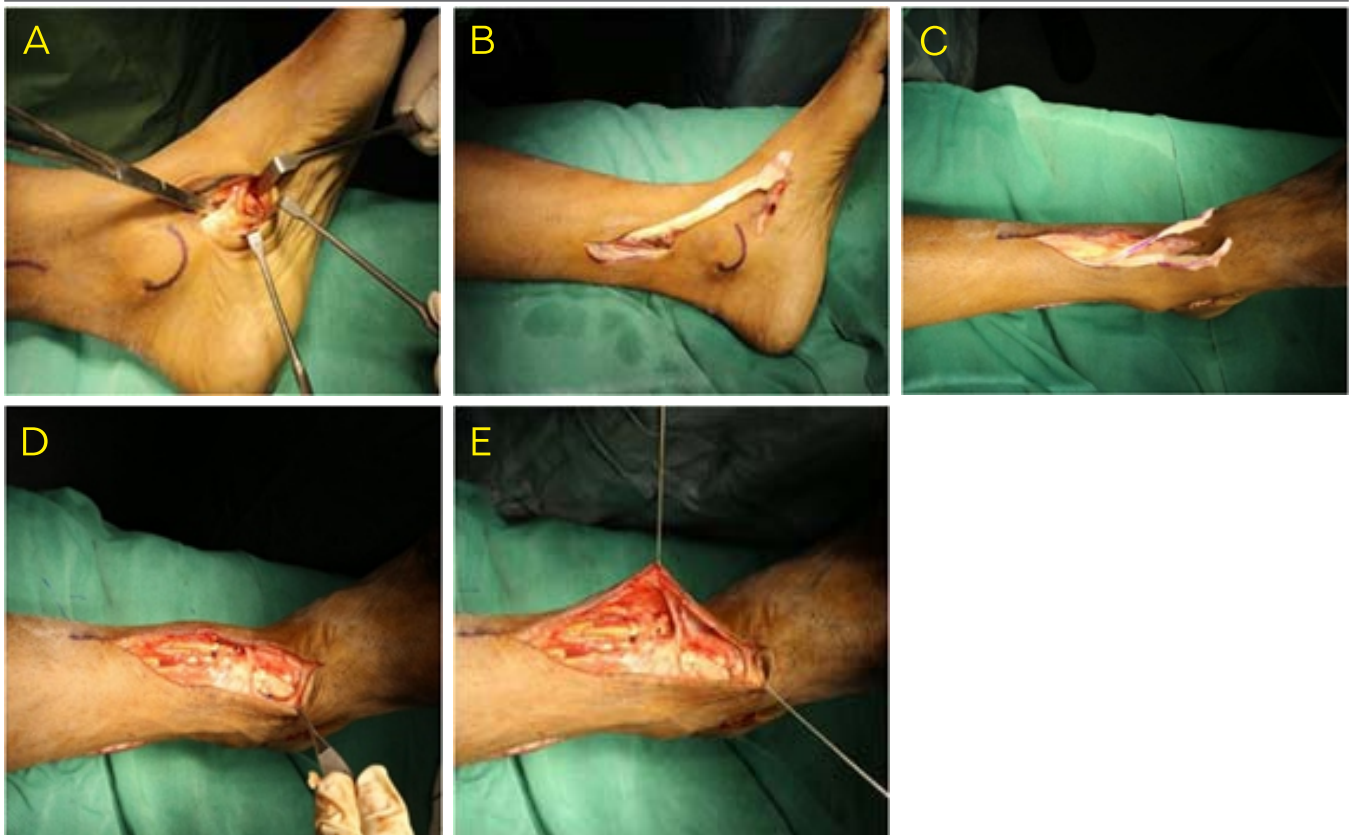
Data Collection and Follow-up

The socio-demographic profile, the clinical findings as well as outcomes were recorded. The outcomes considered were patient satisfaction, hammer toe deformity and dorsiflexion improvement.

A hammer toe deformity occurs when there is flexion at the proximal interphalangeal joint.¹⁴ This was assessed as “yes” or “no” by a non-biased clinician.

FIGURE-1

A. Incision over tuberosity of navicular bone and dividing tibialis posterior tendon. **B.** Tibialis posterior tendon after division **C.** The splits of tibialis posterior tendon brought anteriorly through the interosseous route **D.** One slip of TP tendon sutured to extensor digitorum above extensor retinaculum. **E.** Second slip of TP tendon sutured to tibialis anterior tendon below the retinaculum



Active dorsiflexion was assessed before surgery and at 6 months. Dorsiflexion was categorized excellent when active dorsiflexion was more than 15°, good when active dorsiflexion was between 5° and 15°, moderate when there was no active dorsiflexion and poor when there was presence of plantar flexion.¹² The patient satisfaction was measured using a 10-point visual analog score.¹⁵ The scores 0-3 showed dissatisfaction, 4-6 were neutral and 7-10 showed satisfaction.

Data Analysis

Data entry and analysis was done with SPSS version 25. Quantitative data was presented with mean±SD qualitative variables were presented with frequency and percentage. Qualitative variables between groups were compared between groups with Chi Square test/ Fisher exact test and quantitative variables between were compared between groups with Mann Whitney U test. p-value <0.05 was considered statistically significant.

RESULTS

Both groups were comparable at baseline (age, sex, side, cause of foot drop, hammer-toe), supporting a fair outcome comparison. (Table-I) The modified Bridle showed a clear shift toward better dorsiflexion grades (Excellent/Good 85.7% vs 60.0%), with the overall test narrowly missing significance (p-value=0.051), suggesting a strong

favorable trend. Patient satisfaction was higher with the modified procedure (85.7% vs 57.1%; p-value=0.042). Mean satisfaction scores also favored the modified technique (7.31±1.89 vs 6.11±1.77; p-value=0.001), with a higher median (8 vs 7). Overall, results indicate that the modified Bridle yields better patient-reported outcomes, with a near-significant advantage in functional dorsiflexion. (Table-II)

DISCUSSION

The movement of dorsiflexion helps a person to clear the ground when he walks. When this dorsiflexion is lost, the condition is called foot drop which can be unilateral or bilateral.¹⁶ There may be several causes leading to this condition including stroke, trauma, surgeries, long bed rest, fracture of the pelvis, myopathies as well as cerebral palsy.¹⁷ The patient of foot drop has difficulty in standing and walking, unable to load foot laterally, atrophy of lower leg and contracture.¹⁸ The treatment of foot drop includes repair of nerve with graft or transfer of tendons. Short nerve grafts are more effective compared to longer ones. The transfer of tendons has better outcomes in terms of improvement in function as well as satisfied patient. The long-term complications of tendon transfer include valgus deformity of hindfoot, flatfoot as well as arthritis.¹⁹ The tendons can be transferred by circumtibial (Ober transfer) or by interosseous (Watkins transfer).

TABLE-I

Patients characteristics		Modified Bridle procedure	Bridle Procedure	P-Value
		35	35	
Age (Years) (Mean±SD)		27.00±6.98	28.51±5.57	0.340 ^(c)
Gender	Male	12(34.3%)	16(45.7%)	0.329 ^(c)
	Female	23(65.7%)	19(54.3%)	
Side	Right	15(42.9%)	18(51.4%)	0.473 ^(c)
	Left	20(57.1%)	17(48.6%)	
Cause	RTA	18(51.4)	15(42.9%)	0.564 ^(f)
	FAI	12(34.4%)	10(28.6%)	
	Pelvic trauma	3(8.6%)	6(17.1%)	
	Post POP	2(5.7%)	4(11.4%)	
Hammer toe deformity	Yes	3(8.6%)	5(14.3%)	0.710 ^(f)
	No	32(91.4%)	30(85.7%)	

Note: (F) Fisher exact test, (c) Chi Square test, (c): Mann Whitney U test

TABLE-II

Treatment outcome of patients

		Modified Bridle Procedure	Bridle Procedure	P-Value
		35	35	
Dorsiflexion	Excellent	19(54.3%)	11(31.4%)	0.051 ^(F)
	Good	11(31.4%)	10(28.6%)	
	Moderate	2(5.7%)	10(28.6%)	
	Poor	3(8.6%)	4(11.4%)	
Satisfaction	Satisfied	30(85.7%)	20(57.1%)	0.042 ^(F)
	Neutral	2(5.7%)	9(25.7%)	
	Dissatisfied	3(8.6%)	6(17.1%)	
Satisfaction Score	(Mean±SD)	7.31±1.89	6.11±1.77	0.001 ^(F)
	Median(IQR)	8(2)	7(2)	

Note: (F) Fisher exact test, (c) Chi Square test, (F): Mann Whitney U test

The Bridle procedure of tibialis tendon transfer is as a bridle by anastomosis to anterior tibialis as well as peroneus longus. Bridle procedure is thought to have better subjective and worse kinematic outcomes. Johnson et al even had to face worse outcomes like daily sports, balance test as well as dorsi/plantar flexion of motion. The patients who undergo this procedure do not need to use braces post-operatively.²⁰

We studied 70 patients, 35 in each group. Our patients were younger compared to those studied by Lauer H et al. Mean age of their patients was found out to be 36.3 (± 20.5) years.²¹ This may be because patients who suffer from road traffic accidents or other types of trauma are mostly younger people, and they present for treatment. The leading cause of injury was road traffic accidents (RTA), making up almost half of cases in both groups. Aceves CAR et al showed that the gunshot wounds accounted for 18.2% of foot drop patients, fractures in 18.2% patients, direct contusion in 18.2% patients, knee subluxation in 9% patient, penetrating injury in 9% patient (9%), and iatrogenic injury in 27.2% patients.²²

Modified Bridle procedure rendered excellent dorsiflexion in 54% patients while only 31% of patients undergoing Bridle procedure (p=0.051) had excellent results. Hence, the satisfaction of patients was also more with modified Bridle procedure (p=0.042). Khan MI et al did tibialis posterior

tendon transfer and found out that dorsiflexion after surgery lied in excellent to good category. Almost 17% of patients had moderate dorsiflexion. They also did tibialis anterior tendon transfer in some patients showing excellent results in only 6.7% patients (p-value: 0.016).²³ Hence, transfer of tibialis posterior irrespective of the procedure has better outcome as compared to other tendons. Chung JH et al concluded that 92% of their patients were satisfied with tibialis posterior transfer. The median postoperative passive ankle dorsiflexion was 5.0° which lay in good category of our study. Almost 92.9% patients walked after the surgery.²⁴ Naeem AY et al showed that patients who had posterior tendon anastomosed to tibialis anterior and flexor hallucis longus had excellent dorsiflexion in 20%, good in 30%, moderate in 20%, and finally poor in 20% patients. Half of their patients were unsatisfied with their surgery.²⁵ According to Wen X et al, the dorsiflexion improved after posterior tibial tendon transfer.²⁶

The modification of Bridle procedure we used thus has superiority over Bridle procedure as it is stronger, has balanced pull on the foot, all extensors work, future hammer toe deformity is prevented and there is good range of motion. We studied the procedure on quite a number of patients which shows strength of our study. The limitations which should be overcome in further studies include that long-term follow-up, multicentric trials should be done.

CONCLUSION

This modification of the Bridle procedure where we split the tibialis tendon and anastomosed it to two different tendons both above and below the extensor retinaculum improves the dorsiflexion of majority of patients. Hence, foot-drop patients were widely satisfied with the procedure in comparison to standard Bridle procedure.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

1	Humaira Mushtaq: Data analysis.
2	Atta-ul-haq: Conception.
3	Muhammad Nasrullah: Critical revision.
4	Muhammad Faisal: Interpretation.