ACTA
ORTHOPAEDICA
et
TRAUMATOLOGICA
TURCICA

Author's translation
Acta Orthop Traumatol Turc 2008;42(5):310-315
doi:10.3944/AOTT.2008.310

Extramembranous transfer of the tibialis posterior tendon for the correction of drop foot deformity

Düşük ayak deformitesinin tibialis posterior tendonunun membran dışı transferi ile tedavisi

Ayhan KILIC, Atilla Sancar PARMAKSIZOGLU, Yavuz KABUKCUOGLU, Fuat BILGILI, Sami SOKUCU

Taksim Education and Training Hospital Orthopaedics and Traumatology Department

Amaç: Düşük ayak deformitesinin tedavisinde, tibialis posterior (TP) tendonunun interosseöz membran dışı transferinin etkinliği değerlendirildi.

Çalışma planı: Çalışmada, düşük ayak deformitesi nedeniyle tendon transferi uygulanan 13 hastanın (6 kadın, 7 erkek; ort. yaş 30; dağılım 10-46) 15 ayağı değerlendirildi. On hastada (%76.9) onarılamayacak düzeyde sinir yaralanmasına bağlı deformite vardı. Sinir yaralanmalarının altısı cerrahi girişimler sırasında, diğerleri travma sonucu oluşmuştu. Dört ayakta (%26.7) TP tendonu, tibianın iç-ön yüzünden döndürülerek lateral küneiform kemiğe tenodez, 11 ayakta (%73.4) ise ekstansör hallusis longus, ekstansör digitorum kommünis ve peroneus tertius tendonlarına transfer edildi. Hastalar Stanmore sistemine göre değerlendirildi. Ortalama takip süresi 25.3 ay (dağılım 12-80) ay idi.

Sonuçlar: Stanmore değerlendirme sistemine göre sonuçlar iki ayakta (%13.3) kötü, üç ayakta (%20) orta, üç ayakta iyi, yedi ayakta (%46.7) ise çok iyi bulundu. Hastaların tümü cerrahi sonrasında elde edilen sonuçtan memnundu. Hastaların ayak dorsifleksiyonu ortalama 5˚ (dağılım -5˚/+10˚) idi. Dört ayakta (%26.7) 10˚, altı ayakta (%40) ise 5˚-10˚ arası aktif dorsifleksiyon vardı. Dört hastada (%30.8) ayak sırtında tendon ve dikiş materyallerinin oluşturduğu tümseklikten yakınma dışında, erken dönemde komplikasyona rastlanmadı.

Çıkarımlar: Düşük ayak deformitesinde TP tendonunun membran dışı transferi, hastanın ortez kullanmaksızın yürüyebilmesini sağlayarak yaşam kalitesini artıran bir yöntemdir.

Anahtar sözcükler: Ayak bileği eklemi/cerrahi; ayak deformitesi, edinsel/cerrahi; peroneal nöropati; hareket açıklığı, eklem; tendon transferi/yöntem.

Objectives: We evaluated the effectiveness of extramembranous transfer of the tibialis posterior (TP) tendon for the treatment of drop foot deformity.

Methods: The study included 13 patients (6 females, 7 males; mean age 30 years; range 10 to 46 years) who underwent 15 tendon transfers for drop foot deformity. Ten patients (76.9%) had deformity due to unrepairable nerve injuries, which were associated with surgical procedures in six patients and trauma in the remaining four. In four feet (26.7%), the TP tendon was turned from the intero-anterior aspect of the tibia and fixed by tenodesis to the lateral cuneiform bone, while in 11 feet (73.4%), it was transferred to the extensor hallucis longus, extensor digitorum communis, and peroneus tertius tendons. The patients were assessed according to the Stanmore system questionnaire. The mean follow-up was 25.3 months (range 12 to 80 months).

Results: According to the Stanmore system, the results were poor in two feet (13.3%), moderate in three feet (20%), good in three feet, and very good in seven feet (46.7%). All the patients were satisfied with the final outcome. The mean foot dorsiflexion was 5˚ (range -5˚ to 10˚), which was 10° in four feet (26.7%), and 5˚ to 10˚ in six feet (40%). Apart from complaints of bulging in four patients (30.8%) in the dorsum of the foot due to tendon and suture material, no complications were seen during the early postoperative period.

Conclusion: Extramembranous transfer of the TP tendon for the treatment of drop foot deformity enables the patients to walk without the aid of orthosis and increases their quality of life.

Key words: Ankle joint/surgery; foot deformities, acquired/surgery; peroneal neuropathies; range of motion, articular; tendon transfer/methods.

Correspondence / Yazışma adresi: Dr. Ayhan Kılıç. Taksim Education and Training Hospital Orthopaedics and Traumatology Department, 34433 Taksim, İstanbul, Turkey. Phone: +90212 - 252 43 00 Fax: +90212 - 292 42 55 e-mail: kilicayhan@yahoo.com

Submitted / *Başvuru tarihi:* 25.01.2008 **Accepted / *Kabul tarihi:*** 30.11.2008

Drop-foot deformity is a life-limiting clinical manifestation characterized by loss of ankle dorsiflexion and eversion. Main conditions leading to drop-foot include irrecoverable muscle and nerve injuries, poliomyelitis, drug poisoning, strokes, cerebral palsy, Charcot-Marie-Tooth disease and leprosy.[1,2,3,4] Drop-foot may also develop due to weakness in peroneal muscle group in feet with equinovarus deformity.

In drop-foot deformity, both the swing phase and the toe-contact phase are problematic due to the malfunctioning of the dorsiflexors of the ankle. Steppage gait is only possible through excessive hip and knee flexion. It becomes difficult to transfer the body weight to the ground. Equinus may develop in the ankle in the long term, through passive lengthening of the ankle tendons which lack the dorsiflexion function.

Until present, numerous studies have been conducted concerning the transfer of the tibialis posterior tendon in parts or as a whole to various receiving zones as well as the transfer route.[5-10]

We seek in this study which explores the efficiency of extra-membranous transfer of tibialis posterior tendon in the treatment of drop-foot deformity.

Patients and method

In this study, a retrospective study was carried out on 13 patients (15 ankles) with drop foot deformity who underwent tendon transfer surgery in our clinic between 2000 and 2006.

The mean age of the patients was 30 (10-46) with 6 females (46%) and 7 males (54%). 10 patients (77%) were inflicted with various levels irreversible deformities (%77) due to nerve injuries. The nerve injuries had developed through surgical interventions on hip (3 patients – 23.1%), lumbar (2 patients – 15.4%) and knee (1 patient – 7.7%) regions. Other trauma causes included forensic injuries in 3 patients (23.1%) and traffic accident in 1 patient (7.7%). Of the two patients where two sides were involved, one had non-progressive neuropathy and the other had developed deformity due to damage to the first motor neuron. The peripheral nerve injuries were at the sciatic nerve level in 8 patients (80%) (Table 1). In the group of patients where drop-foot developed due to trauma, the mean duration of pre-transfer paralysis was 14 months (range, 8-23). All patients were using orthoses. Furthermore, the drop-foot deformity was accompanied by toe-drop and claw-toe deformities in 4 patients (26.6%).

Active and passive ranges of motion in the joint were measured during the pre-operative period, using the "Neutral-0" method with the patient in supine position and with the knee in extension. Tibialis posterior tendon was assessed through the Grace Warren method. The patients with a lack of active dorsiflexion and eversion in the ankle had a minimum of 20o passive range of motion in terms of dorsiflexion (except Patient 9). One patient (Patient 9) had 20° passively uncorrectable equinus and varus deformity on both feet. The strength of tibialis posterior muscle was found to be 4/5 in two patients (Patient 5 and 9) and 5/5 in the others.

Solely posterior tibial tendon transfer was employed in all patients except one. In our patient who had cerebral palsy, where the manifestation was accompanied by equinus and varus deformity, transfer was employed in both legs together with open achilloplasty, posterior capsulotomy and lateral column shortening (Patient 9).

Bilateral transfer was employed in 2 patients (15.4%). Tenodesis was accomplished by passing the TP tendon through a tunnel drilled in the lateral cuneiform bone and suturing it onto itself. In 11 patients (84.6%) the TP tendon was transferred onto the EHL, EDC and PT tendons.

Surgical technique

All patients were positioned supine under tourniquet, with a pad under the feet. Tibialis posterior (TP) tendon was detached with a 2 cm incision made on its attachment point at the foot medial, on the navicular bone. The tendon then was removed from the tendon sheath with a second incision starting at 3 cm and extending to 7 cm above the medial malleus and was freed by taking care not to damage the artery vein in the tendo-muscular complex. A crescent-shaped third incision starting just below the skin creases at the back of the foot and extending over to the peroneal tendons was made along the extensor hallucis longus (EHL) tendon, thereby revealing the extensor hallucis (EHL), extensor digitorum (EDL) and peroneus tertius (PT) tendons. A subcutaneous tunnel extending across the tibia medial fascia was made with the aid of a tendon transfer clamp and the TP tendon was transferred to the back of the foot. After being

transferred through the EHL, EDL and PT tendons, the TP tendon was sutured onto itself using No.2/0 non-absorbable suture material. In the meanwhile, the ankle was positioned at 10o dorsiflexion and at maximum possible eversion. The tourniquet was then released to check for hemorrhage and a lower leg circular cast was applied maintaining the position of the foot (Picture 1).

Where the TP tendon was short and/or thick (3 patients), an incision splitting the tendon in two parts was made starting from 1-1.5 cm proximal of the tendon distal end and extending over to the required length (about 6 cm). The upper end of the incised part of the tendon was released and distally turned to permit lengthening. The tendon was brought to its pre-incision position by being transferred under the EHL, EDL and PT tendons and by using No.2/0 non-absorbable suture material, tenodesis was employed on the tendons which are wrapped like a "sandwich" In two patients, the TP tendon was passed through a tunnel drilled in the lateral cuneiform bone and was sutured onto itself with No.2/0 non-absorbable suture material.

The circular cast on the lower leg was removed after 6 weeks with subsequent use of AFO. In the first four weeks of 8-week AFO usage, the patients were trained on recognizing the direction of movement and putting it into action. Full weight bearing with AFO was allowed in the subsequent 4-week period.

The patients were assessed by the Stanmore assessment system(Table 1)[8] The mean follow-up period was 25.3 months (12-80).

Results

According to the Stanmore assessment system and the results were poor in two feet (13.33%), fair in three feet (20%), good in three feet (20%), and very good in seven feet (46.66%); (Table 2). All our patients were satisfied with the results of the surgery. One of our patients with very good results scored the highest with 91 points (Picture 2). The patient with poor results who also had limited recreation was partially relieved of the requirement to use orthosis (Picture 3). Postoperative functions were assessed to be poor in our patient where bilateral deformity had developed due to non-progressive neuropathy , who TP – Tenodesis on lateral cuneiform bone.

Table 1. stanmore assessment questionnaire

Pain	(15 points)
Never	15
Occasionally	10
Sometimes	5
Serious pain	0
Need for orthosis	(15 points)
No need	15
Rerely (once a week)	10
Sometimes (twice a week)	5
Frequent (more than twice a week)	0
Ability to wear normal shoes	(5 points)
Yes	5
Only special models	3
No	0
Functions	(10 points)
Normal daily activity and normal recreation	10
Normal daily activity and limited recreation	6
Limited daily activity and limited recreation	3
Seriously limited daily activity and recreation	0
Degree of active dorsiflexion	(25 points)
Grade 4-5	25
Grade 4	20
Grade 3	10
Grade 2 and lower	0
Dagree of active dorsiflexion	(25 points)
More than 6°	25
0-5°	20
–5 / –1°	10
–10 / –6°	5
Less than –11°	0
Foot posture	(5 points)
Plantigrade, balanced, no deformity	5
Plantigrade; mild deformity	3
Obvious deformity, misalignment	0

100-85 points: Very good; 84-70 points: Good; 69-55 points: Fair;55 points:Poor

Mean ankle dorsiflexion in patients were +5˚ (range, -5˚/ +10˚). Four ankles (26.6%) had an average of 10˚ active dorsiflexion and a range of motion of 40˚, whereas 6 ankles had 5˚-10˚ active dorsiflexion and 20˚ of average range of motion. Five ankles (33.4%) lacked dorsiflexion, with the foot in plantigrade position and with a range of motion below 10˚.

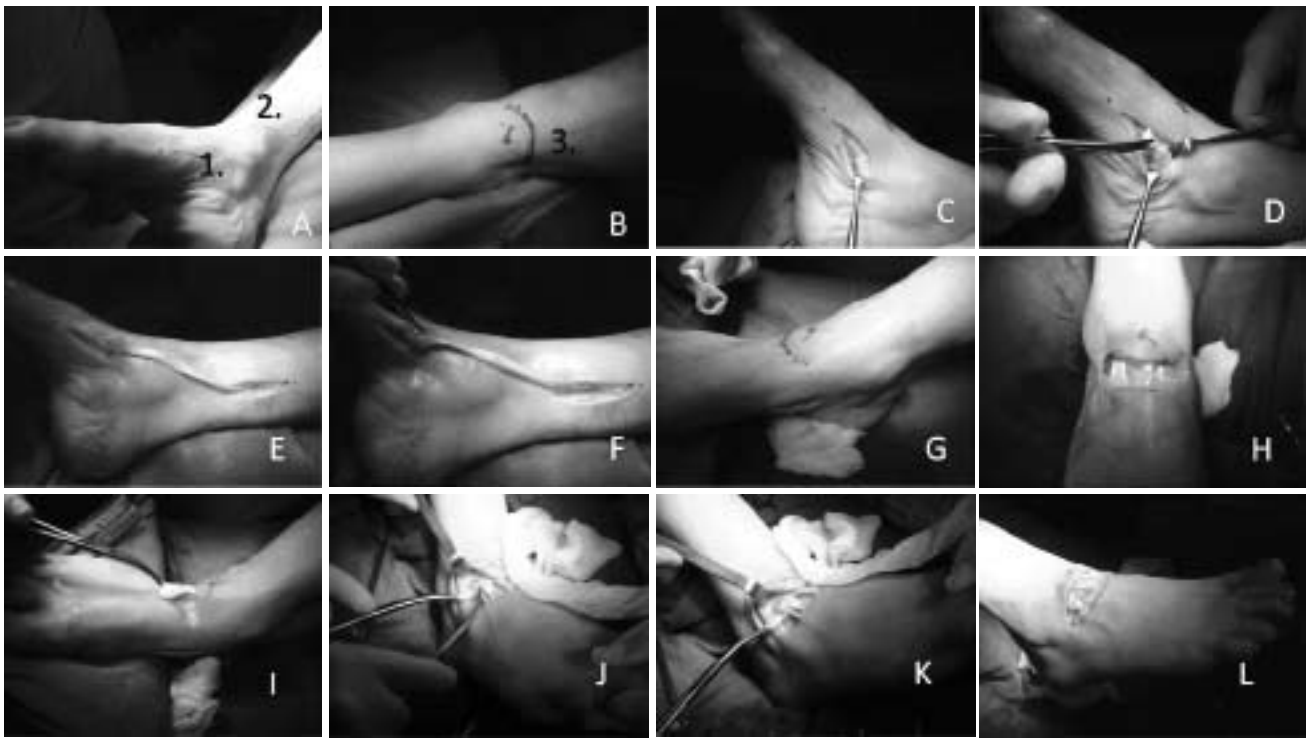

Figure 1. Surgery process where in tibialis posterior tendon was transferred through extra--membranous route to the toe extensors and peroneus tertius.

Claw-toe and drop-toe deformities were restored, which were observed in four cases (26.6%) and which were attributed to stretching due to uncompensated toe flexors and to the impact from the stretched long extensors.

No early period complications were encountered apart from the complaints of four patients (30.8%) of the bulge due to tendon and suture material on the dorsum of the foot. Throughout the follow-up period, there was no medial arch flattening or weakness in plantar flexion due to TP insufficiency.

Discussion

In our study, posterior tibial tendon transfer was employed on 13 patients with drop-foot deformity who have difficulties in conducting everyday activities. Released from its attachment place at the navicular bone in the foot medial, the posterior tibial tendon was subcutaneously transferred through the tibia medial fascia the dorsal fascia of the foot onto the EHL, EDC and PT tendons in 11 feet (73.3%), and onto lateral cuneiform bone in 4 feet (26.6%). Of the 15 cases, an average of 5° active dorsiflexion (ran-

Figure 2. Aged 28, F, right, 30 months follow-up; the patient with very good results according to Stanmore assessment system (91 points)

Figure 3. Aged 36,both sides, paralyzed by neurogenic causes,16 months follow-up. Stanmore score is 49 points at left and 52 points at right foot.

ge, 5°/+10°) was achieved in 10 (66.6%). Both of the problematic swing and toe-contact phases were improved. Orthosis requirement was eliminated in two of the three patients (20%) who had an ankle range of movement of less than 10° and who lacked active dorsiflexion in the ankle. The functionality attained through this technique was satisfactory in our group of patients including a limited number of patients. Furthermore, the claw-toe deformity observed in four feet (26.6%) was restored through the strengthening of the long extensors of the toe and by attaining plantigrade transfer of body weight onto the floor.[12] On the other hand, no early period complications were encountered other than the complaints of four patients (30.8%) of the bulge due to tendon and suture material on the dorsum of the foot. Throughout the follow-up period, there was no medial arch flattening or weakness in plantar flexion associated with TP insufficiency. [10,13-15]

Transferring the TP tendon through the interosseous membrane provides a stronger foot dorsiflexion compared to the technique where the tendon is turned around the tibia, since a shorter route is covered. However, the risk of vascular injuries and late-term contraction in the subcutaneous passage are the key problems the tendon.[6] Wagenaar and Louwerens [9] was splitting the TP tendon into two parts before the subcutaneous transfer process and employing tendon to tendon fixing, and they reported excellent results concerning 10 feet out of 13 in their study with a follow-up period of 3 years. While the subcutaneous transfer of the TP tendon to the dorsum of the foot by taking it around the tibia medial fascia is an easier and less risky method, it provides a lesser degree of range of motion in the joint on the other hand.[6,9] Then again, transferring the tendon superficially over the retinacular flap of the dorsal extensor reduces the transfer route and enhances biomechanical efficiency. [2, 5] In a study conducted by Özkan et al [6] which the surgical techniques employed in our study show similarities, the TP tendon was split into two parts with one strip was transferred to tibialis anterior tendon, and the other to the EHL, EDC and PT tendons. 70% successful results were reported in this study. The tibialis anterior tendon was not included in the transfer process in the cases of our study. The ankle was kept in a lesser degree of dorsiflexion (10°) during fixation. This resulted in a relatively limited strength in active dorsiflexion while leading to a lesser extent of achilloplasty requirement.[6,13,16]

Another significant issue is defining the tenodesis point of the TP tendon on the receiving field. Transfers to various tarsal bones and to tendons have been reported in the literature.[1,2,7-10] The transfer of the TP tendon onto the EHL, EDC, PT tendons provides a strong pronator impact and facility in fixation. It furthermore enables dorsiflexion in the hallux through tenodesis effect. The drawbacks concerning the extension of the TP tendon over to the transfer location on the other hand, include the technical challenges caused by tendon and suture tensions in the dorsal foot.[1]

On the other hand, it should be noted that the transfer of the TP tendon as a whole might lead to flattening of the medial arch of the foot and weakening of the plantar flexion in the long term.[14]

Limited number of patients and the shortness of follow-up period constitute the shortcomings of our study. Furthermore, the fact that the transfer location and fixing method of the tendon have varied in two patients could be considered another shortcoming.

In conclusion, the intermedial subcutaneous transfer of the TP tendon onto the structures in the foot dorsal in drop-foot deformity is a method substantially enhancing the life quality of the patient by permitting unproblematic walking without use of orthosis. The transfer of the TP tendon to long extensor tendons of the toe and to the peroneus tertius tendon is an efficient and low-risk method which permits easy fixation in the recovery of the dorsiflexion and eversion ranges of motion of the foot and which is also efficient in terms of further pathologies.

References

1. Soares D. Tibialis posterior transfer for the correction of foot drop in leprosy. Long-term outcome. J Bone Joint Surg [Br] 1996;78:61-2.
2. Root L, Miller SR, Kirz P. Posterior tibial-tendon transfer in patients with cerebral palsy. J Bone Joint Surg [Am] 1987;69:1133-9.
3. Barnes MJ, Herring JA. Combined split anterior tibial-tendon transfer and intramuscular lengthening of the posterior tibial tendon. Results in patients who have a varus deformity of the foot due to spastic cerebral palsy. J Bone Joint Surg [Am] 1991;73:734-8.
4. Garozzo D, Ferraresi S, Buffatti P. Common peroneal nerve injuries in knee dislocations: results with one-stage nerve repair and tibialis posterior tendon transfer. J Orthopaed Traumatol 2002;2:135-7.
5. D'Astous JL, MacWilliams BA, Kim SJ, Bachus KN. Superficial versus deep transfer of the posterior tibialis tendon. J Pediatr Orthop 2005;25:245-8.
6. Ozkan T, Tuncer S, Ozturk K, Aydin A, Ozkan S. Surgical restoration of drop foot deformity with tibialis posterior tendon transfer. [Article in Turkish] Acta Orthop Traumatol Turc 2007;41:259-65.
7. Bekler H, Beyzadeoglu T, Gokce A. Tibialis posterior tendon transfer for drop foot deformity. [Article in Turkish] Acta Orthop Traumatol Turc 2007;41:387-92.
8. Yeap JS, Birch R, Singh D. Long-term results of tibialis posterior tendon transfer for drop-foot. Int Orthop 2001;25: 114-8.
9. Wagenaar FC, Louwerens JW. Posterior tibial tendon transfer: results of fixation to the dorsiflexors proximal to the ankle joint. Foot Ankle Int 2007;28:1128-42.
10. Vigasio A, Marcoccio I, Patelli A, Mattiuzzo V, Prestini G. New tendon transfer for correction of drop-foot in common peroneal nerve palsy. Clin Orthop Relat Res 2008;(466): 1454-66.
11. Warren AG. The correction of foot drop in leprosy. J Bone Joint Surg [Br] 1968;50:629-34.
12. Bernstein RK. Physical signs of the intrinsic minus foot. Diabetes Care 2003;26:1945-6.
13. Moran MF, Sanders JO, Sharkey NA, Piazza SJ. Effect of attachment site and routing variations in split tendon transfer of tibialis posterior. J Pediatr Orthop 2004;24:298-303.
14. Vertullo CJ, Nunley JA. Acquired flatfoot deformity following posterior tibial tendon transfer for peroneal nerve injury: a case report. J Bone Joint Surg [Am] 2002;84:1214-7.
15. Carayon A, Bourrel P, Bourges M, Touze M. Dual transfer of the posterior tibial and flexor digitorum longus tendons for drop foot. Report of thirty-one cases. J Bone Joint Surg [Am] 1967;49:144-8.
16. Goh JC, Lee PY, Lee EH, Bose K. Biomechanical study on tibialis posterior tendon transfers. Clin Orthop Relat Res 1995;(319):297-302.