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

Düşük ayak deformitesinin tibialis posterior tendonunun
membran dışi transferi ile tedavisi

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

Amaç: Düşük ayak deformitesinin tedavisinde, tibia-
lis posterior (TP) tendonunun interosseöz membran dışi
transferinin etkinliği değerlendirildi.

Çalışma planı: Çalışmada, düşük ayak deformitesi nede-
niyile 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 yara-
lanmasına bağlı deformite vardı. Sinir yaralanmalarının
altısı cerrahi girişimler sırasında, diğerleri travma sonucu
oluşmuştu. Dört ayakta (%26.7) TP tendonu, tibianın iç-ön
yüzünden dönürtürerek lateral küneiform kemiğe tenodez,
11 ayakta (%73.4) ise ekstansör hallucis longus, ekstansör
digitorum kommünis ve peroneus tertius tendonlarına
transfer edildi. Hastalar Stanmore sistemine göre değer
lendirildi. Ortalama takip süresi 25.3 ay (dağılım 12-80)
ay idi.

Sonuçlar: Stanmore değerlendirme sistemine göre so-
nuçlar iki ayakta (%13.3) kötü, üç ayakta (%20) orta, üç
ayakta iyi, yedi ayakta (%46.7) ise çok iyi bulundu. Has-
taların tümü cerrahi sonrasında elde edilen sonuçta
memnuniyet çıkmıştır. 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 hast-
ta (%30.8) ayak sırtında tendon ve dikiş materyallerinin
oluşturduğu tümseklikten yakınma dışında, erken dönem
de komplikasyona rastlanmadı.

Çıkarımlar: Düşük ayak deformitesinde TP tendonunun
membran dış transferi, hastanın ortez kullanmaksizin
yürüyebilmesini sağlayarak yaşam kalitesini artırır bir
yöntemdir.

Anahtar sözcükler: Ayak bileği eklemi/cerrahi; ayak deformi-
tesi, edinsel/cerrahi; peroneal nöropati; hareket açıklığı, ekle-
tendon transferi/yöntem.

Objectives: We evaluated the effectiveness of extramem-
branous 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 un-
derwent 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 cu-
neiform 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 ac-
cording 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 mate-
rial, no complications were seen during the early postop-
erative period.

Conclusion: Extramembranous transfer of the TP ten-
don 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/sur-
gery; peroneal neuropathies; range of motion, articular; tendon
transfer/methods.
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.\(^\text{[1,2,3,4]}\) 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.\(^\text{[5-10]}\)

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 20° 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 achillolasty, 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 10° 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). Post-operative 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>
<thead>
<tr>
<th>Table 1. stanmore assessment questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pain</strong></td>
</tr>
<tr>
<td>Never</td>
</tr>
<tr>
<td>Occasionally</td>
</tr>
<tr>
<td>Sometimes</td>
</tr>
<tr>
<td>Serious pain</td>
</tr>
<tr>
<td><strong>Need for orthosis</strong></td>
</tr>
<tr>
<td>No need</td>
</tr>
<tr>
<td>Rerely (once a week)</td>
</tr>
<tr>
<td>Sometimes (twice a week)</td>
</tr>
<tr>
<td>Frequent (more than twice a week)</td>
</tr>
<tr>
<td><strong>Ability to wear normal shoes</strong></td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Only special models</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td><strong>Functions</strong></td>
</tr>
<tr>
<td>Normal daily activity and normal recreation</td>
</tr>
<tr>
<td>Normal daily activity and limited recreation</td>
</tr>
<tr>
<td>Limited daily activity and limited recreation</td>
</tr>
<tr>
<td>Seriously limited daily activity and recreation</td>
</tr>
<tr>
<td><strong>Degree of active dorsiflexion</strong></td>
</tr>
<tr>
<td>Grade 4-5</td>
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<tr>
<td>Grade 4</td>
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<tr>
<td>Grade 3</td>
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<tr>
<td>Grade 2 and lower</td>
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<tr>
<td><strong>Degree of active dorsiflexion</strong></td>
</tr>
<tr>
<td>More than 6°</td>
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<tr>
<td>0-5°</td>
</tr>
<tr>
<td>−5 / −1°</td>
</tr>
<tr>
<td>−10 / −6°</td>
</tr>
<tr>
<td>Less than −11°</td>
</tr>
<tr>
<td><strong>Foot posture</strong></td>
</tr>
<tr>
<td>Plantigrade, balanced, no deformity</td>
</tr>
<tr>
<td>Plantigrade; mild deformity</td>
</tr>
<tr>
<td>Obvious deformity, misalignment</td>
</tr>
</tbody>
</table>

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°.
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-
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 plan- tigrade transfer of body weight onto the floor. 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. 

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. Wagenaar and Louwerens 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. Then again, transferring the tendon superficially over the retinacular flap of the dorsal extensor reduces the transfer route and enhances biomechanical efficiency.

In a study conducted by Özkan et al 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 achil- loplasty requirement.

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. 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.

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.

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