Original Article

Extramembranous Transfer of the Tibialis Posterior Tendon for the Treatment of Drop Foot Deformity in Children

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Abstract

Background: To study the efficacy of extramembranous transfer of the tibialis posterior (posterior tibial) tendon for the treatment of drop foot deformity in children.

Materials and Methods: This study included 24 patients (11 girls and 13 boys) with drop foot deformity, who underwent tibialis posterior tendon transfer. The mean age was 12.33 years (range: seven to18 years), and the mean follow-up period was 32.54 months (range: 24 – 55 months). Drop foot developed due to different levels of nerve injury associated with trauma or surgical operation in 18 (75 %) patients, and due to meningomyelocele in six (25 %) patients. Tibialis posterior tendon was flipped from the anteromedial aspect of the tibia and transferred to the lateral cuneiform bone. The patients were evaluated via the Stanmore system questionnaire.

Results: Evaluating the outcomes by the Stanmore system, poor results in two feet (8.3 %), fair in two feet (8.3 %), good in eight feet (33.3 %), and excellent in 12 (50 %) feet were obtained. All patients were satisfied with the postoperative outcomes. The mean active ankle dorsiflexion was 8.96 degrees (range: zero to 20 degrees).

Conclusions: Extramembranous transfer of the tibialis posterior tendon is a quite successful method in retrieving active dorsiflexion of the foot in patients with drop foot deformity. It is a method which eliminates the need for orthosis and enhances the quality of life of patients.

Keywords: Foot drop, transfer of the posterior tibial tendon, tibialis posterior tendon

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Introduction

Drop foot deformity is a clinical picture involving the loss of dorsiflexion and eversion of the ankles that limits the daily activities of the patients. Common etiologic factors include unrepaired muscle and nerve injuries, poliomyelitis, drug intoxications, cerebral palsy, Charcot-Marie-Tooth disease, and leprosy.[1,2] Since the foot cannot be raised enough during the swing phase of walking, the forefoot contacts the ground and walking is impaired. Pelvic elevation and hip and knee flexion is required to lift the foot off the ground. In order to facilitate walking, ankle-foot orthosis (AFO), which allows plantar flexion as far as neutral position, is used.[3] In time, equinovarus deformity of the foot is developed by the effect of posterior tibial tendon (PTT).[4,5] The goal of the therapy is to enable dorsiflexion of the foot.[6,7] Therapy options include tenodesis, arthrodesis, and tendon transfers.[8,9] Watkins,[10] Codivilla, and Putti are the pioneers of the technique of anterior transfer of the PTT.[3,11–13] Basic issues such as the route of transfer, the type of insertion, the recipient tendons, and the tension of the transferred tendon are technically important, and they are still being discussed.[11]

In the present study, the patients who underwent extramembranous transfer of the PTT because of drop foot were retrospectively evaluated, and the efficacy of this treatment in drop foot was evaluated.

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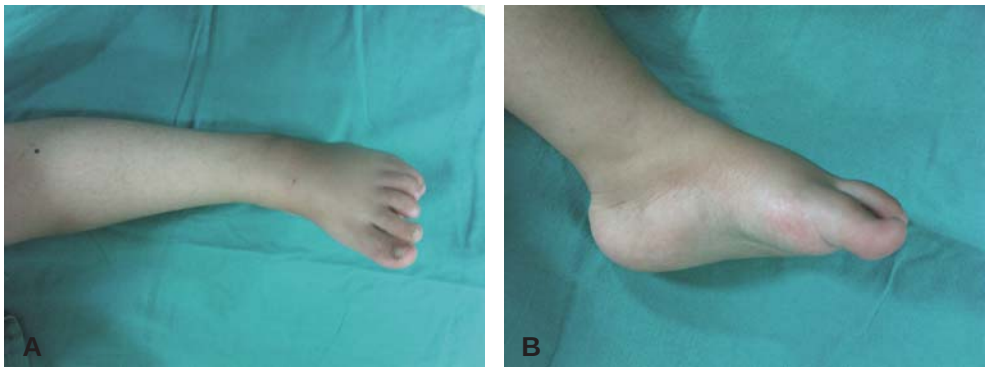
Materials and Methods

In the present study, 24 patients (11 girls and 13 boys) who underwent tendon transfer for drop foot between 2000 and 2009 were retrospectively evaluated. Prior to the operation, informed consents of all patients were obtained. The mean age of the patients was 12.33 years (range: seven to 18 years). Foot drop was associated with different levels of nerve injury caused by a trauma or surgical intervention in 18 (75 %) patients and with meningomyelocele in the remaining six (25 %) patients. The nerve injury was at the sciatic nerve level in 10 (41.6 %) patients which was caused by intramuscular injection in four, penetrating injuries in three, gunshot in two, and developmental hip dysplasia surgery in one patient (sciatic nerve injury caused by overstretching of the nerve during reduction of the hip). Lesion was at the peroneal nerve level in eight (33.3 %) patients which was caused by trauma (fracture of the fibular head and crush injury) in four, by pressure of casting in two, and by surgery of the proximal fibula in two patients (common peroneal nerve injury while tumor excision from the fibular head). The mean duration of paralysis before tendon transfer was 21.63 months (range: 12 – 33 months) in patients who suffered from drop foot due to nerve injury associated with surgical intervention or due to trauma. All patients were using ortheses. The patients who had a tibialis posterior muscle strength lower than 4/5 (seven patients), who couldn't participate in the physical therapy program (nine patients), who had mental retardation (two patients), and who couldn't be followed up (three patients) were excluded from this study.



Figures 1. A, B. Figures showing the preoperative images of an eight-year-old girl patient with meningomyelocele sequelae.

Figures 2. A, B, C, D. Peroperative Achilles tendon lengthening, posterior capsulotomy, and extramembranous transfer of the posterior tibial tendon to the lateral cuneiform bone.

Prior to the operation, active and passive movements of the ankle were measured in the supine position during knee extension. Voluntary and independent contraction of the tibialis posterior muscle was taught by the physiotherapist. The patients who had passive ankle dorsiflexion less than 20 degrees had stretching exercises of the Achilles tendon. Except for three patients, the passive ankle dorsiflexion range of motion in patients who had no active dorsiflexion and eversion of the ankle was at least 20 degrees. One patient had 20 degrees of equinus and varus deformity in both feet, not passively correctable. Tibialis posterior muscle strength was 4/5 in six (25 %) patients and 5/5 in the remaining. All patients underwent PTT transfer. Additional Achilles tendon lengthening was performed in three patients, who had < 20 degrees of dorsiflexion in the ankle. The patient with equinus and varus deformity associated with meningomyelocele underwent Achilles tendon lengthening, posterior capsulotomy, and lateral column shortening in addition to tendon transfer. A tunnel was drilled in the lateral cuneiform bone; PTT was passed through this bone tunnel and sutured back onto itself providing tenodesis. A below-knee circular cast was applied for six weeks, and then an AFO was used. In the first four weeks of the eight-week AFO use, the patient was recommended to learn the direction of motion of the transferred tendon and to retrain the muscle functions. In the last four weeks, full-load bearing with AFO was permitted. The outcomes of the patients were evaluated according to the Stanmore system (Table 1).[14]

Statistics

Data were analyzed using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) version 18.0. Pre- and postoperative scores were compared with the paired t-test. A P- value < 0.05 was considered significant.

Table 1. Stanmore system questionnaire

Pain	**15 Points**
No pain at any time	15
Mild pain	10
Moderate pain	5
Severe pain	0
Need for orthoses	**15 Points**
No	15
Occasionally (once a week)	10
Frequently (twice a week)	5
Regularly (greater than twice a week)	0
Normal shoes	**5 Points**
Yes	5
Yes, but prefers certain types	3
No	0
Functional outcome	**10 Points**
Normal daily activity and normal recreation	10
Normal daily activity and limited recreation	6
Limited daily activity and recreation	3
Severe limitation on daily activity and recreation	0
Muscle power	**25 Points**
Grade 4+ or 5	25
Grade 4	20
Grade 3	10
Grade 2 or less	0
Degree of active dorsiflexion	**25 Points**
Greater than 6 degrees	25
0-5 degrees	20
–5 / –1 degrees	10
–10 / –6 degrees	5
Less than –11 degrees	0
Foot posture	**5 Points**
Plantigrade, balanced, no deformity	5
Plantigrade, mild deformity	3
Obvious deformity or malalignment	0
100 – 85 points: excellent; 84 – 70 points: good; 69 – 55 points: fair; less than 55 points: poor.	

Table 2. Comparison of the Stanmore scores and joint motions of the patients

	N	Mean	Minimum	Maximum	Standard Deviation
Preoperative score	24	17.21	0	41	10.18
Postoperative score	24	76.13	0	100	26.10
Active dorsiflexion	24	8.96	0	20	5.78
Active plantar flexion	24	24.96	10	36	7.11
$P < 0.005$, comparison of the preoperative and postoperative scores using the t-test.					

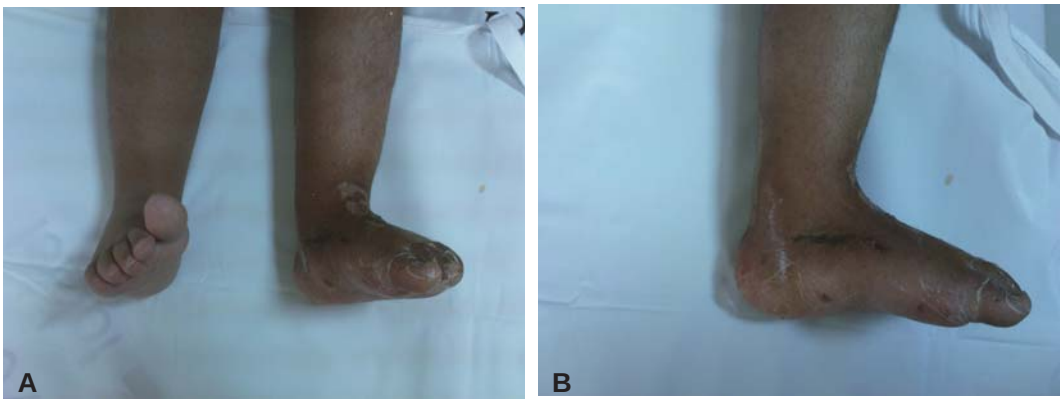
Results

The mean follow-up period was 32.54 months (range: 24 – 55 months). According to the Stanmore system, the results were poor in two (8.3 %) feet, fair in two (8.3 %) feet, good in eight (33.3 %) feet, and excellent in 12 (50 %) feet. All of the patients declared that they were satisfied with the outcomes of the surgery even though two patients were evaluated as bad and two as fair outcomes according to the Stanmore system. We think that this was caused due to patients' main preoperative complaints that were lack of lifting the forefoot and tripping which were relieved after the surgery. The mean active ankle dorsiflexion was 8.96 degrees (range: zero to 20 degrees), and the active plantar flexion was 24.96 degrees (range: 10 – 36 degrees), (Table 2). An absence of dorsiflexion was observed in two feet (8.3 %); the feet were in plantigrade position and the range of motion was less than 10 degrees. Three patients with poor and fair outcomes underwent tendon transfer together with Achilles tendon lengthening, and one patient underwent tendon transfer together with Achilles tendon lengthening, posterior capsulotomy, and lateral column shortening. No complication was observed in the early period, except for protuberance on the dorsal surface of the foot due to tendon and suture material in five patients (30.8 %). During the follow-up period, flattening of the medial arch and weakness in plantar flexion due to tibialis posterior muscle insufficiency was not observed in any of the patients.

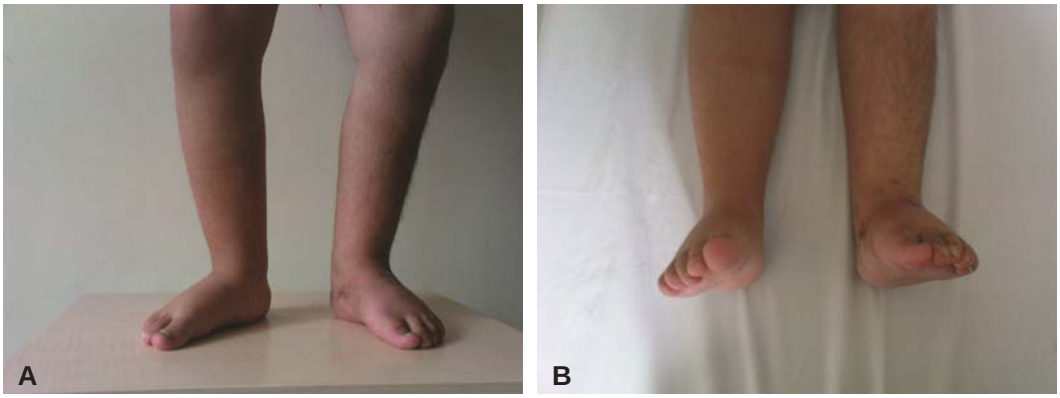
Discussion

Peroneal nerve injury is the leading cause of drop foot. Besides being prone to injury due to its localization, post-injury healing is poorer in the peroneal division of the sciatic nerve compared to that in the tibial division.[15] Foot drop may occur due to neurologic (peripheral nerve injury, neuropathy, cerebral lesions) and muscular (injuries of the extensor muscles, compartment syndrome) problems.[16] Despite the advances in nerve physiology and microneurosurgery, tendon transfer is required to enable normal walking in a substantial part of patients with drop foot due to peroneal nerve paralysis.[17] Therefore, primarily the nerve should be repaired in the early period of the peroneal nerve injuries and tendon transfer should be performed in cases without satisfactory neurologic improvement.[16] It has been shown that tendon transfer significantly enhances nerve regeneration in patients who had peroneal nerve repair.[18]

The route of transfer of the PTT to the dorsal surface of the foot is a matter of discussion in PTT transfers.[16] Performing the transfer through the interosseous membrane is a physiologic way and provides strong dorsiflexion of the foot. However, risk of vascular injury during the procedure, narrowing of the transition tunnel in the late-term, and adhesions are the main problems.[8,16,19] Wagenaar and Louwerens[20] reported an excellent outcome in 10 of 13 feet in which PTT transfer through the interosseous membrane was performed. Flipping the PTT from the anteromedial aspect of the



Figures 3. a, b . The postoperative third month images of the patient.



Figures 4. a, b. The postoperative first year images of the patient.

tibia and transferring it to the dorsal surface of the foot via subcutaneous route is an easier and less risky method, but provides less joint space.[7,16,20] Goh, et al.[11] showed that the interosseous route is more effective in maintaining a better dorsiflexion. Soares[21] stated that, both transfer methods provide a dorsiflexion higher than the neutral position in 80 % of the patients and that both methods are equally successful in retrieving foot dorsiflexion. The transfer of the tendon superficially over the extensor retinaculum that covers the dorsal aspect of the foot shortens the transfer route and increases the biomechanical efficacy.[4,22] In their study performed on 41 patients, Ozkan, et al.[16] split the PTT, passed it through the circumtibial route, and transferred one of the branches to the tibialis anterior tendon and the other branch to the extensor hallucis longus, extensor digitorum longus, and peroneus tertius tendons, and reported a success rate of 70 %. Including the good and excellent results, we had a success rate of 83.3 %.

The place where the PTT is attached to, is another important issue. In the literature, transfers to different tarsal bones and tendons have been reported.[1,22–24] The transfer of the PTT to the extensor hallucis longus, extensor digitorum longus, and peroneus tertius tendons provide a strong pronator effect and easy fixation. It enables the dorsiflexion of the toe through tenodesis effect. The technical difficulties involve the limitations in extending the PTT to the transfer area and the tension in the ankle due to the tendons and sutures.[1] Soares[21] stated that ankle dorsiflexion would be decreased by approximately 15 to 20 degrees in patients in whom the PTT was transferred to the tendon. They suggested that the tendons should be fixed as the foot was in 20 degrees dorsiflexion, predicting the future stretching likely to occur in the muscle-tendon unit. Shortening of the Achilles tendon may occur in patients who suffer from drop foot for a long time, and the tendon can be extended in cases with a passive dorsiflexion of less than 20 degrees.[16] Achilles tendon lengthening was performed on three of our patients with a passive dorsiflexion of less than 20 degrees.

We prefer the circumtibial route because besides the ease of application, it has a low risk of tendon adhesion formation.

In conclusion, transfer of the PTT from the anteromedial surface of the tibia to the dorsal surface of the foot via subcutaneous route is a method that enables the patient walk without an orthosis, and it considerably enhances the quality of life of the patient.

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