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Posterior tibialis tendon transfer for steppage gait: Functional results and indications

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ABSTRACT

Introduction: Common peroneal nerve injury is the most frequent nerve deficit affecting the lower limbs. This leads to foot drop and a so-called steppage gait. Primary surgical nerve repair has an unfavorable outcome in some series. One alternative is posterior tibialis tendon transfer, a procedure designed to achieve active dorsiflexion. The aim of this paper is to report the results we have obtained with this surgery.

Methods: Between January 2008 and June 2016, a total of 38 patients underwent posterior tibialis tendon transfer, but only those 29 who had a minimum 12-months follow-up were included in analysis. A subcutaneous approach was used for the transfer, with tendon-to-tendon suturing employed, using the tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneal tendons as targets. The Stanmore Scale was used to rate outcomes.

Results: Final results were excellent in 15 patients (52%), good in seven (24%), fair in three (10%) and poor in four (14%).

Conclusions: This tendon transfer procedure has a high success rate, both in our series and in the literature. Considering the poor results observed in primary nerve repair in some patients, we believe that posterior tibialis tendon transfer should be considered for the treatment of foot drop in selected patients.

1. Introduction

Common peroneal nerve (CPN) injury, also known as external popliteal nerve or common fibular nerve injury, is the most frequent nerve lesion in the lower limb. It may be due to the nerve's superficial position at the level of the fibular neck, even though, in higher lesions at the hip level, its involvement is three times more frequent than damage involving the tibial nerve. Injuries to the CPN produce a foot dorsiflexion palsy, due to the loss of innervation of the tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneal muscles. In turn, this leads to foot and digital drop, and progression to the abnormal gait known as *steppage gait*. Additionally, the presence of preserved function in the posterior tibial nerve and muscle leads to a supinated equinovarus foot deformity. These gait abnormalities, which also cause the foot to drag, may produce falls. To avoid this, the patient must flex his or her knee and hip to a greater degree than normal to produce exaggerated elevation of the foot. This deficit is also associated with anesthesia over the lateral side of the leg and foot.

Primary reconstruction of the CPN yields functional results that are usually worse than those achieved with other forms of nerve reconstruction (Corradi, Isola, & Rinaldi, 1997; Kline, 1972; Mackinnon & Dennon, 1988; Sedel, 1987). As reported in the literature, this could be related to the nerve's particular fascicular arrangement and the small number of fasciculi in the CPN relative to the amount of connective tissue (Tomaino, Day, Papageorgiou, Harner, & Fu, 2000). Another factor apparently associated with poorer results is the imbalance between the normal function of the plantar flexor muscles and inactivity of the dorsal flexors (Millesi, 1987).

One existing alternative to primary nerve reconstruction is posterior tibialis tendon transfer. The Peripheral Nerve Surgery team within the Department of Neurosurgery at Hospital de Clínicas started performing this procedure in 2008 for the management of foot drop in selected cases. The goal of the current study was to retrospectively evaluate the results that we achieved with this technique.

2. Materials and methods

We included all patients who (1) underwent posterior tibialis

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Table 1
Rehabilitation protocol.

PREOPERATIVE CARE
Evaluation of the affected limb
Strengthening exercises for posterior chain of the leg
Load transfer training to the different regions of the forefoot
Plantar proprioceptive stimulation
Stability activation of the mediolateral ankle joint
Electrical stimulation with Russian currents to promote muscular trophism
IMMEDIATE POSTOPERATIVE CARE
30 days of plaster cast immobilization
INTERMEDIATE POSTOPERATIVE CARE
Scar treatment
Passive flexibilization exercises
Tibio/tarsal joint passive mobility
SECOND WEEK
Closed kinetic chain exercises
Partial load transfer
Active assisted Mobility
Ball physiotherapy
Anti-inflammatory physiotherapy
Electrostimulation
THIRD WEEK
Closed kinetic chain exercises
Open kinetic chain exercises with partial load
Ball physiotherapy with partial load
Exercises with minimal elastic resistance
Proprioception
Supports and load transfer in the plantar zone
Electrostimulation with Russian currents
Passive elongation exercises
FOURTH WEEK
Open kinetic chain exercises with a full load
Elastic resistance exercises
Active exercises
Gait and new flexor re-education
Inclined plane rehabilitation exercises
Coordination exercises of the lower limb for hip, knee and ankle
Activation of action and reaction on different surfaces (flat, elastic and point elastic surface)
FIFTH WEEK
Correction of gait postural vices
Muscle chains conditioning
Conditioning for everyday activities

Table 2
Stanmore scale (modified).

PAIN (15 points)	
No pain	15
Mild pain	10
Moderate pain	5
Severe pain	0
NEED FOR AN ORTHOTIC (15 POINTS)	
No	15
Occasionally (once weekly)	10
Frequently (twice weekly)	5
Regularly (greater than twice weekly)	0
NORMAL SHOES (5 POINTS)	
Yes	5
Yes, but prefers certain types	3
No	0
FUNCTIONAL OUTCOME (10 POINTS)	
Normal daily and normal recreational activities	10
Normal daily but limited recreational activities	6
Limited daily and recreational activities	3
Severe limitations in both daily and recreational activities	0
MUSCLE POWER (BMRC grading) (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°	25
0°–5°	20
−5° to −1°	10
−10° to −6°	5
Less than −11°	0
TOTAL SCORE	**95**

tendon transfer procedures performed by either one of the two surgeons in the Peripheral Nerve Surgery team (GDM, MS), between January 2008 and June 2016, and (2) were followed for a minimum of 12 months post-operatively.

Over the time analyzed, 38 tendon transfers were performed in our department to improve foot dorsiflexion, 30 of which had follow-up for at least 12 months. One patient with adequate follow-up lacked adequate adherence to our postoperative protocol (inadequate period of immobilization and subsequent rehabilitation), and also was excluded from analysis. Individualized data for the remaining 29 patients are summarized in Table 3. Eighteen patients presented with a CPN injury at the level of the knee, while the injury was higher, at the thigh or buttock, in eleven. Two of the 29 patients also presented with a tibial nerve lesion, but its subsequent reinnervation enabled tendon transfer. A lumbosacral plexus injury was identified in only one patient.

The same surgical technique was used in all cases. The subcutaneous circumferential approach was chosen to achieve rerouting of the posterior tibialis muscle tendon to the dorsum of the foot. Then, tendon-to-tendon sutures were placed to the tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneal tendons.

With this procedure, the posterior tibialis tendon is resected at its insertion into the navicular bone in the foot through a 3 cm-incision over the bone, previously identified by palpation. A second 5–7 cm incision is made 3–4 cm above the medial malleolus to release the tendinous portion of the posterior tibialis muscle. It is extremely important, at this stage of the surgery, to identify the posterior tibial neurovascular bundle to avoid any injury. By a third incision on the dorsum of the foot, created 2–3 cm below the line between the two malleoli, the target tendons are exposed. Then, the posterior tibialis tendon is tunneled subcutaneously around the tibia. A wide tunnel is recommended to allow for adequate mobility of the tendon, and later splitting. One of these halves is then sutured to the anterior tibialis tendon, and the other to the remaining tendons. All the sutures are positioned distally to the retinaculum extensorum. The goal is to achieve 10° ankle dorsiflexion and the maximum eversion possible.

After wound closure, an immobilization cast is applied for four weeks. After this time, the cast is removed and replaced by a Walker type boot. At this stage, a rehabilitation program, detailed in Table 1, must be started.

The Stanmore Scale (Table 2) was used to assess the results of the surgical procedure.

3. Results

In fifteen patients, the tendon transfer was performed as a stand-alone procedure. Neurolysis before the tendon transfer was performed in 7 patients. In seven patients the neurolysis and tendon transfer were performed at the same time and in 1 patient we performed nerve reconstruction with a graft and tendon transfer at the same surgery.

At final follow-up, an excellent Stanmore score was achieved in 15 patients (52%), while the score was rated good in seven (24%), fair in three (10%) and poor in four (14%) (Fig. 1).

Further individualized analysis of each sub-category of the Stanmore scale revealed that pain was not an important complaint in this group of patients. An orthotic was either not needed (21 patients) or needed only when the patient wore normal shoes (two patients) (Fig. 2). Concerning functional outcomes, nine patients were able to perform normal daily activities, including a return to playing sports, while 12 patients could carry out normal daily activities with mild limitations during recreational activities. Muscle power (Fig. 3) and the degree of active dorsiflexion achieved (Fig. 4) were greater than M3 in 21 patients, and equal to or greater than 0° in 22 patients, respectively.

One patient required a second surgical intervention because of lost