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Original article

Comparison between tibial nerve block with anaesthetics and neurotomy in hemiplegic adults with spastic equinovarus foot

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ABSTRACT

Objective: The aim of the study was to compare the effect of diagnostic motor nerve block with anaesthetics and of selective tibial neurotomy in the treatment of spastic equinovarus foot in hemiplegic adults.
Methods: In this prospective observational study, 30 hemiplegic adults with spastic equinovarus foot benefited from a diagnostic nerve block with anaesthetics followed by a selective tibial neurotomy performed at the level of the same motor nerve branches of the tibial nerve. Spasticity (Ashworth scale), muscle strength (Medical Research Council scale), passive ankle dorsiflexion (ROM), gait parameters (10 meters walking test) and gait kinematics (video assessment) were assessed before and after the nerve block and two months and two years after selective tibial neurotomy.
Results: The decrease in spasticity and the improvement in gait kinematics were similar after the diagnostic nerve block and two months and two years after neurotomy. The diagnostic nerve block did not revealed the slight increase in gait speed and in tibialis anterior muscle strength that was observed two years after neurotomy.
Conclusion: This study suggests that diagnostic nerve block with anaesthetics and selective neurotomy equally reduce spasticity and improve gait in case of spastic equinovarus foot in hemiplegic adults. Diagnostic nerve block can be used as a valuable screening tool before neurotomy.

1. Introduction

Spastic equinovarus foot (SEF) is a common deformity among hemiplegic patients, with an incidence estimated at 18% of the stroke survivors [1]. The deformity is mainly caused by spasticity of the triceps surae (soleus and gastrocnemius muscles) and tibialis posterior muscles, sometimes associated with Achilles' tendon shortening and weakness and/or imbalance of the peronei and tibialis anterior muscles. SEF contributes to poor locomotor performance after stroke [2]. Moreover, SEF is frequently associated with other gait disturbances such as knee recurvatum [3]. Patients frequently need ankle-foot orthosis and/or crutch for walking. Treatment of SEF includes physical therapy, muscle stretching, orthosis, functional electrical stimulation, chemical neurolysis with phenol or alcohol, botulinum toxin (BTXa) injections, tendon transfers and lengthening, and selective tibial neurotomy (STN) [4]. Several randomized, double-blind, placebo-controlled studies have demonstrated that BTXa injections can reduce spasticity, pain and use of walking aids, and increase active ankle dorsiflexion, whereas the effect on gait velocity has been more equivocal [5–8]. However, BTXa has a reversible effect necessitating repeated injections every four to six months. In such cases, permanent surgical treatment, such as STN, is indicated in order to definitively correct the SEF [9].

STN is a neurosurgical procedure in which the motor nerve branches innervating the spastic muscles are partially sectioned. This old technique has been reintroduced by French and Belgian neurosurgical teams over the last few decades and was improved by use of intraoperative electrical stimulation and operating microscopes [9–16]. Partial section of the motor nerve branches results in a permanent reduction of spasticity by interrupting afferent (Ia) and efferent (α and γ) fibers mediating the spastic monosynaptic reflex arc. The surgeon carefully spares sensory fibers to avoid sensory deficit and neuropathic pain. STN is indicated in case of disabling SEF caused by spasticity of the gastrocnemius, soleus, tibialis posterior and flexor hallucis longus

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muscles without associated musculo-tendinous shortening. The motor nerve branches innervating the flexor digitorum longus muscle are spared in order to avoid sensory deficits because these branches are frequently very close to the sensory fibers innervating the sole of the foot. The most frequently reported complaints that may justify STN were foot instability with repetitive ankle sprains, pain related to excessive pressure on the toes, and difficulties tolerating ankle foot orthosis. The long-lasting beneficial effect of STN on spasticity, gait speed and equinovarus deformity in patients with SEF has been suggested in several longitudinal studies [10–12,14,16–18]. A recent randomized controlled trial evaluating the effect of BTXa and STN in the SEF confirms the efficacy of the STN to reduce spasticity and to improve the ankle kinematics [9].

In the assessment of SEF, especially before STN, a selective diagnostic nerve block (DNB) with anaesthetics of the motor nerve branches of the tibial nerve innervating the soleus, gastrocnemius and tibialis posterior muscles is recommended and preferred to a non-selective tibial nerve block [13,19–22]. The DNB involves injecting a small dose (usually 1 mL) of local anaesthetics at the level of the motor nerve. The nerve block eliminates spasticity after few minutes and for some hours, allowing assessment of the respective contribution of the different spastic muscles, the degree of Achilles' tendon shortening, and the weakness of the antagonistic muscles. Before proposing STN, it is necessary that a reduction in the equinovarus deformity following a DNB with anaesthetics and/or botulinum toxin injections can be demonstrated [9,11–13,15,16,23]. However, the necessity to perform DNB before proposing STN was suggested only by three studies which have compared the effect of DNB and STN in respectively two, seven and 11 patients, supporting the need for larger studies [13,20,24].

The aim of the present study was to prospectively evaluate the effect of DNB with anaesthetics of the motor nerve branches of the tibial nerve and of STN in the treatment of SEF in hemiplegic adults. Our research hypothesis was that the DNB would provide an identical decrease in spasticity and in equinovarus deformity as STN and therefore predicts the improvement obtained after STN.

2. Methods

2.1. Participants

The patients were consecutively recruited by an interdisciplinary spasticity group in a referral center of a university hospital from 1997 to 2005. All the patients benefited from a selective DNB with anaesthetics of the motor nerve branches of the tibial nerve innervating the soleus, tibialis posterior ± gastrocnemius muscles and from a STN performed at the same nerves. Inclusion criteria were a stroke history or trauma of more than one year, an age over 18 years, an ability to walk without shoes, the presence of a disabling SEF improved by DNB with anaesthetics and a passive ankle dorsal range of motion with flexed knee at neutral angle after DNB. Exclusion criteria were a previous history of surgery or injection with phenol and injection with BTXa in the last 6 months and the need for a tendon surgery in addition to neurotomy. Our institutional review board approved the study and informed consent was obtained from all the patients.

2.2. Diagnostic nerve block with anaesthetics

The DNB with anaesthetics was performed at the level of the different motor nerve branches of the tibial nerve until the triceps spasticity had disappeared. If possible, a selective DNB was preferred to a global tibial nerve block, which induces a non selective decrease of the spasticity of all the muscles of the calf and sensory disturbances which may interfere with gait. The DNB was performed by means of a disposable needle for conduction anaesthesia, gauge 23 and 100 mm in length (Top Corp., Japan), coupled to an EMG apparatus (Nicolet Viking, Nicolet Biomedical, Inc., Madison, WI). The motor nerve branches were located according to coordinates previously determined in relation to anatomic landmarks [21]. A 1 mL dose of lidocaïne 2% (Xylocaïne® 2%) was injected on each motor nerve branch when a clinical muscular contraction and an EMG detection response (for the soleus and gastrocnemius muscles) were still obtained with a low stimulation intensity (0.01 ms and 4 mA). The local anaesthetics usually act after few minutes allowing to assess the effect on the spasticity of the targeted muscles. The DNB was performed first at the superior motor nerve branch to the soleus muscle followed, if necessary, by the motor nerve branch to the tibialis posterior and to the gastrocnemius muscles. If necessary, the DNB was finally performed at the tibial nerve. The effect of the DNB lasts for several hours.

2.3. Surgical treatment

STN was performed under general anaesthesia according to previous description [9,12,14,16,23]. Muscle relaxant drugs were not used in order to prevent any interference with the intraoperative electrical stimulation. The patient was placed in a prone position and a vertical cutaneous incision was made below the crease of flexion of the popliteal fossa. The tibial nerve was dissected and the motor nerve branches to the soleus, gastrocnemius, tibialis posterior and flexor hallucis longus were identified with intraoperative tripolar electrical stimulation (Newmedic, France). The selected motor nerve branches were partially sectioned over a 5 mm length under the microscope. The extent of nerve section was determined according to the degree of spasticity and to the peroperative residual muscular contraction under electrical stimulation. Patients were allowed to walk the day after surgery and no immobilization or cast was used. During the two years period of the study, patients continued to benefit from a 30 minutes daily rehabilitation program including personal triceps stretching in load, muscle strengthening and gait rehabilitation. This rehabilitation program was the same as performed before the inclusion in the study. Use of oral antispastic medications was not monitored.

2.4. Test protocol

Before and after DNB and two months and two years after STN, the degree of spasticity, muscle strength, passive range of ankle motion, gait parameters and gait kinematics were assessed by the same unblinded therapist. The degree of spasticity was measured at the triceps surae, tibialis posterior, quadriceps and hamstring muscles by using the modified Ashworth scale [25]. The muscle strength was measured at the quadriceps, hamstring, tibialis anterior, peronei and triceps muscles by using the MRC (Medical Research Council graded 0–5) scale in sitting position. The passive range of ankle motion (ROM in degrees) was measured with a goniometer with the knee in the flexed (soleus) and extended (soleus and gastrocnemius) position taking the tibia, the center of the heel and the first metatarsophalangeal joint as landmarks. Gait parameters (gait speed, step cadence and step length) were obtained during a 10-meter walking test. Gait kinematics (equinus, varus and knee flexion both in swing and stance phase) was measured using video analysis and expressed in degrees; the gait was recorded with a digital camera recorder and analysed on a 20 inches screen. The following landmarks were used: the trunk and the femur for the hip, the femur and the tibia for the knee, the