Alexandria Journal of Medicine xxx (2017) xxx–xxx

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Contents lists available at ScienceDirect

Alexandria Journal of Medicine

journal homepage: http://www.elsevier.com/locate/ajme

Evaluation of selective peripheral neurotomies in the treatment of refractory lower limb spasticity in adults

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ARTICLE INFO

Article history:
Received 14 April 2017
Revised 6 June 2017
Accepted 14 June 2017
Available online xxxx

Keywords:
Selective peripheral neurotomies
Spasticity
Neuroablative surgeries
Functional neurosurgery

ABSTRACT

Background: "Selective peripheral neurotomies" (SPNs) are indicated for the treatment of refractory focal and multifocal spasticity of lower limbs in adults.
Objective: To evaluate the surgical results of selective peripheral neurotomies in 20 adult patients who had refractory focal & multifocal spasticity of the lower limbs, follow up period of one year.
Patients and Methods: Prospective study included 20 adult patients who had refractory spasticity of the lower limbs. Preoperative evaluation for muscle tone using Modified Ashworth Score (MAS), muscle power using Medical Research Council Scale (MRCS), functional assessment using Oswestry Functional Scale (OFS) and Range Of Motion (ROM) using manual goniometry were done for all patients. All cases underwent surgery in the form of SPN of tibial, obturator, sciatic and/or femoral nerves. Follow up of the patients was done at 10th day, 3, 6 months and one year postoperatively.
Results: The mean age of patients was 31.35 ± 12.42 years. There were statistically significant improvement of muscle tone, muscle power, functional assessment and range of motion between preoperative and one year postoperative values. Improvement of the muscle tone was from a preoperative Mean ± SD of 3.60 ± 0.68 on MAS to a postoperative 2.30 ± 0.86 at one year, improvement of muscle power on MRCS was from preoperative Mean ± SD 3.75 ± 1.08 to postoperative 4.08 ± 0.69 at one year, There was a functional improvement from a preoperative Mean ± SD of 3.0 ± 0.73 on OFS to 3.60 ± 0.60 at one year postoperatively. Also, there was a significant improvement between preoperative ROM Mean ± SD 61.25 ± 15.29 and one year postoperatively 72.25 ± 12.19.
Conclusions: Selective peripheral neurotomies could effectively improve muscle tone, muscle power, functional performance & range of motion in patients with refractory focal and multifocal spasticity in the lower limbs.

1. Introduction

Peripheral neurotomies (PNs) are old neurosurgical techniques that were introduced hundred years ago. Recently, the development of microsurgical techniques and electrophysiological monitoring lead to the reintroduction of PNs. PNs are dedicated for severe focal and multifocal spasticity, when injection of botulinum toxin becomes ineffective and surgery cannot be delayed any more.[1–3]

Peripheral neurotomies aim at restoring the balance between the muscle tone of agonist and antagonist muscles by lowering excessive spasticity. Spasticity is decreased in PNs by sectioning the efferent motor fibers of the stretch reflex of the nerve supplying the target muscle.[3]

Surgery should be done so that the increased hypertonia is minimized without a drop of the useful muscle tone or loss of the motor and sensory residual functions. PNs can be done "selectively" by microsurgical dissection of the motor fascicles and their monitoring using intra-operative electrical nerve stimulation.[3–8]

Neurotomy consists of sectioning part of one or several motor fascicles of the nerves innervating the target muscle(s), in which spasticity is excessive. Motor branches should be targeted where they are isolated from the nerve trunk or they can be dissected

Abbreviations: SPNs, selective peripheral neurotomies; PNs, peripheral neurotomies; MRCS, Medical Research Council Scale; MAS, Modified Ashworth Score; OFS, Oswestry Function Scale; ROM, range of motion.

Peer review under responsibility of Alexandria University Faculty of Medicine.

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http://dx.doi.org/10.1016/j.ajme.2017.06.006
2090-5068/

and identified as motor fascicles within the nerve trunk before giving a known branch.[8]

There is no standardized basis for the extent of the partial section. However, most experienced spasticity surgeons agree that motor fascicles sectioning must include 50–80% (usually 75%) of the fibers supplying a targeted muscle. Before doing any PN, nerve block test of the motor nerves innervating the target muscles is recommended.[7,9]

2. Aim of the work

The aim of this work was to evaluate the surgical results of "selective peripheral neurotomies" of tibial, obturator, sciatic and/or femoral nerves in 20 adult patients who had refractory focal and multifocal spasticity of the lower limbs.

3. Patients and methods

This was a prospective study which included 20 patients who had refractory focal or multifocal spasticity of the lower limbs. The study was done in the "Department of Neurosurgery, Ain-Shams University Hospitals, Cairo, Egypt" in the period between November 2014 and November 2016. Ethics committee approval for the study design and statistical methodology was obtained.

3.1. Inclusion criteria

Age > 18 years old.

Focal or multifocal spasticity refractory to optimal pharmacological and\or physical therapy.

Positive anesthetic nerve block test.

3.2. Exclusion criteria

Negative anesthetic nerve block test.

Contraindication to surgery and\or anesthesia.

Selection and assessment of patients were performed carefully by assessment of muscle tone by "Modified Ashworth Score" (MAS),[10] motor power function using "Medical Research Council Scale" (MRCS),[11] function assessment by "Oswestry Function Scale" (OFS)[12] and range of motion (ROM) assessment by manual goniometry.

Assessment of MAS, MRCS and ROM were performed only for muscle groups involved in harmful spasticity (muscle groups that underwent neurosurgical intervention) and the mean of the scores were used for pre and post- operative statistical evaluation. For statistical analysis purposes, the grade of 1+ on the MAS was considered a 2, and 1 was added to the remaining grades, so the grades ranged from 0 to 5.

Visual gait analysis and videotaping were done for all selected patients with focal and multifocal lower limb spasticity to aid in differentiating harmful spasticity from functionally useful spasticity. Nerve blocks with 3 ml of 0.25% xylocaine were used for predicting the outcome of peripheral neurotomy insuring patients' satisfaction.

All surgeries were performed under general anesthesia and without long-acting muscle relaxants so that the motor responses elicited by nerve stimulation of motor branches could be detected.

Microsurgical resection of at least 50% of the targeted motor branches was performed. The surgical planning was taken in a multidisciplinary approach for each patient, depending on the degree of preoperative spasticity, the functional performance, and the presence of muscle or bony deformities.

Tibial neurotomy was indicated for spastic foot deformity, sciatic neurotomy for hamstring hypertonia, obturator neurotomy for adductor spasm, and femoral neurotomy for hypertonic quadriceps femoris.[13,14]

Post-operative evaluation visits were scheduled at the 10th day, 3rd month, 6th month and one year; evaluation measures were recorded for each patient for statistical comparison with the pre-operative measurements.

3.3. Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level. We used Wilcoxon signed ranks test for abnormally distributed quantitative variables, to compare between two periods.[15,16]

4. Results

Twenty patients were included in this study; 13 males (65%), the mean age was 31.35 ± 12.42 years. Eleven patients (55%) had paraparesis, seven patients (35%) had hemiparesis, and two patients (10%) had quadriparesis. Different etiologies of spasticity in this study were described in (Table 1).

A total of 60 selective peripheral neurotomies were performed: 28 were tibial, 15 were obturator, 15 were sciatic, and 2 were femoral neurotomies. Multiple level neurotomies were done as a single staged surgery.

Orthopedic surgeries for muscle contracture were done simultaneously with neurotomies in six patients (30%).

4.1. Muscle tone

There was a marked reduction of the muscle tone from a preoperative mean MAS of 3.60 ± 0.68 to a postoperative score of 2.25 ± 0.79 at the 10th day, 3 months, 6 months and 2.30 ± 0.86 at one year postoperatively ($p < 0.001$) (Table 2 and Fig. 1).

4.2. Muscle power

There was no statistically significant difference between preoperative evaluation and the 6th month follow up assessment ($p = 0.066$). However, there was a statistically significant change at the one year follow up assessment ($p = 0.041$) (Table 3).

Five patients (25%) showed improvement on MRCS. However, a decrease of 1–2 grades in muscle power by MRCS in the operated limb was found in almost all patients in the early post-operative period. This may be related either to surgical manipulations of the nerves or to the pre-existing weakness (due to UMNL) became

Table 1
Distribution of different etiologies of spasticity in this study.

Etiology of spasticity	Number of patients
Cerebral origin	
Post traumatic	5
Post stroke	4
Cerebral palsy	3
Spinal origin	
Post traumatic	4
Spinal tumors	2
Hereditary spastic paraplegia	2