

SHORT COMMUNICATION

DIAGNOSTICS OF NERVE IMPULSES TRANSMISSION PATHOLOGY IN PATIENTS WITH SUSPECTED THORACIC OUTLET SYNDROME USING CLINICAL NEUROPHYSIOLOGY TESTS

DIAGNOSTYKA PATOLOGII PRZEWODNICTWA IMPULSÓW NERWOWYCH U CHORYCH Z PODEJRZENIEM ZESPOŁU GÓRNEGO OTWORU KLATKI PIERSIOWEJ Z WYKORZYSTANIEM BADAŃ NEUROFIZJOLOGII KLINICZNEJ

Agata Maria Kaczmarek, Anna Kalek, Paulina Wietrzak, Juliusz Huber

Department of Pathophysiology of Locomotor Organs, Poznań University of Medical Sciences, Poland

ABSTRACT

Introduction

Thoracic Outlet Syndrome (TOS) is a group of conditions characterized by compression of the nerves, arteries and veins in the lower neck and upper chest area. On average, six physicians of different specialities need 4.3 years to develop TOS diagnosis. Early detection of changes in transmission of nerve impulses within the brachial plexus may lead to faster and more effective treatment of patients.

Aim

The aim of the study is to present the scheme of diagnostic tests of clinical neurophysiology contributing to the objective diagnosis of TOS, as well as the positive results of tests in a group of sixteen patients with clinically confirmed pathological symptoms.

Material and methods

Sixteen patients with clinically diagnosed TOS and sixteen healthy people as a control group aged from 18 to 36 participated in this study. In both groups of subjects, bilateral clinical neurophysiological diagnostics tests were carried out: an examination of the sensory perception with von Frey's filaments within C4-C8 dermatomes, examination of surface electromyography (sEMG) during maximal contractions when recordings from proximal and distal muscles of the upper extremities were performed, the electroneurographic transmission of nerve impulses in selected nerves of the upper extremities (ENG) and motor evoked potentials recordings induced with the magnetic field (MEP) following oververtebral C5 and C6 stimulation.


Results

Comparing to studies performed in a control group of healthy volunteers, more than 50% of patients with clinical symptoms of TOS had confirmed abnormalities in the diagnostic tests of clinical neurophysiology, unilaterally or bilaterally.

Conclusions

In the diagnosis of TOS, sEMG recordings from the distal muscles of upper extremities during maximal contractions after induction of ischemia ("hand-raised test"), ENG segmental

Author responsible for correspondence:

Agata Maria Kaczmarek
Department of Pathophysiology of Locomotor Organs
28 Czerwca 1956 No 135/147
61-545 Poznań, Poland
email: agatamm.kaczmarek@gmail.com
 <https://orcid.org/0000-0002-1614-0644>

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examination of nerve impulses transmission in motor fibers after stimulation of the median and ulnar nerves, and MEP examination after oververtebral C5 and C6 stimulation are particularly useful. Confirmation of a relatively high percentage of positive TOS tests in patients requires a greater number of neurophysiological examinations.

Keywords: Thoracic Outlet Syndrome, neurophysiological diagnostics, motor evoked potentials

STRESZCZENIE

Wstęp

Zespół górnego otworu klatki piersiowej (TOS) jest grupą objawów powstających poprzez ucisk nerwów, tętnic i żył w obrębie szyi oraz górnej części klatki piersiowej. Do postawienia trafnej diagnozy TOS statystycznie potrzeba sześciu lekarzy różnych specjalności, a od momentu wystąpienia pierwszych objawów do podjęcia procesu leczniczego mija zwykle 4,3 roku. Wczesne wykrycie zmian w przewodnictwie impulsów nerwowych w obrębie splotu ramiennego może prowadzić do szybszego i skuteczniejszego leczenia pacjentów.

Cel

Celem pracy jest przedstawienie schematu badań diagnostycznych neurofizjologii klinicznej przyczyniających się do obiektywnej diagnostyki TOS, jak i wyników pozytywnych testów w grupie szesnastu chorych z klinicznie potwierdzonymi objawami patologicznymi.

Materiał i metody

W badaniu wzięło udział 16 pacjentów z klinicznie rozpoznany TOS oraz 16 zdrowych osób w wieku od 18 do 36 lat jako grupa kontrolna. W obu grupach przeprowadzono testy z zakresu obustronnej klinicznej diagnostyki neurofizjologicznej: badanie percepcji czucia powierzchniowego filamentami von Frey'a w zakresie dermatomów C5-C8, badanie elektromiografii powierzchniowej (sEMG) w warunkach maksymalnego skurczu przy rejestracji z wybranych mięśni proksymalnych i dystalnych kończyn górnych, badanie elektroneurograficzne przewodnictwa impulsów nerwowych w wybranych nerwach kończyn górnych (ENG) oraz metodę rejestracji ruchowych potencjałów wywołanych indukowanymi polem magnetycznym (MEP) po stymulacji nadkręgosłupowej C5 i C6.

Wyniki

W porównaniu do badań wykonanych w grupie kontrolnej zdrowych ochotników, u ponad 50% chorych z klinicznymi objawami TOS potwierdzono nieprawidłowości w przeprowadzonych testach diagnostycznych neurofizjologii klinicznej jedno- lub obustronnie.

Wnioski

W diagnostyce TOS szczególnie przydatne są rejestracje sEMG odprowadzane z mięśni dystalnych kończyn górnych w warunkach maksymalnego skurczu po wywołaniu niedokrwienia („test uniesionych rąk”), badanie odcinkowe przewodnictwa impulsów nerwowych ENG we włóknach ruchowych po stymulacji nerwów pośrodkowych i łokciowych oraz badanie MEP po stymulacji nadkręgosłupowej C5 i C6. Potwierdzenie stosunkowo dużego odsetka pozytywnych testów u chorych w kierunku neurofizjologicznej diagnostyki TOS wymaga większej ilości zbadanych przypadków.

Słowa kluczowe: zespół górnego otworu klatki piersiowej, diagnostyka neurofizjologiczna, ruchowe potencjały wywołane

Introduction

Thoracic Outlet Syndrome (TOS) is a group of conditions characterized by the compression of the neurovascular bundle, which includes the brachial plexus, the subclavian artery, the subclavian vein and the axillary vein. These structures are located in the lower neck and upper chest area. Compression may occur in the crevices of the oblique muscles, the costal-clavicular space and the thoracic space. Due to the complaints reported by the patient, we can distinguish three types of TOS (neurogenic, venous and arterial). Neurogenic TOS (nTOS) symptoms include soreness, numbness and weakness in the upper limb, and they are reproducibly aggravated by any activity that requires elevation arms, e.g. brushing hair. This is the most common type of TOS. Venous TOS (vTOS) is the second most common TOS syndrome, representing approximately 3% of cases. It manifests itself in lividity and pain in the upper limbs, subsequently raising term for a long period of time. The paraesthesia is caused by ischemia rather than nerve compression. Arterial TOS (aTOS) is quite rare (approximately 1% of cases). It is characterized by pain, pallor of the skin and paraesthesia.

A characteristic feature for all types of TOS is the presence of symptoms only when the upper limbs are raised or abducted. If the nerves are compressed, or the muscles are under the ischemia condition, pain radiates along the medial part of the arm and forearm to the IV and V fingers. Additional symptoms may include paraesthesia and sensory loss in the area of the innervated ulnar nerve, muscle weakness and often one-sided Raynaud's phenomenon. In the diagnostic process, there are used the following tests: Addson's test, Roos test, Allen's test (Sadeghi-Azandaryani et al., 2009). Depending on the causes of TOS, there are different medical procedures recommended for patients' treatment. The therapeutic effects of pharmacological treatment,

physiotherapy, and relaxation procedures are reported. In some cases, surgery is required.

The neurophysiological examination plays a supplementary role in the clinical diagnosis of TOS, and the electroneurographical examination (ENG) is the most appreciated. It reveals the abnormalities in the transmission of neural impulses in the motor fibers of the median nerve more than the ulnar nerve (recorded from the muscles as the M and F waves) (Fernández-González and Suárez-Fernández, 1998) and sensory fibers (recording of the SCV potential) of the ulnar nerve more than the median nerve, unilaterally or bilaterally (Haghighi et al., 2005; Tolson, 2004).

During ENG recordings of evoked potentials induced by electrical stimulation of nerves with an electrical stimulus on their anatomical course in patients with suspected TOS, abnormalities in the transmission impulses should be observed along the entire length of the tested nerves with a preference from the Erb's point level. The usefulness of MEP (motor evoked potentials) in the conformation of TOS diagnosis is inconclusive (Haghighi et al., 2005), and its significant effectiveness in TOS detection is only suspected.

Aim

The aim of the study is to present the scheme of diagnostic tests of clinical neurophysiology contributing to the objective diagnosis of TOS, as well as the presentation of positive results of tests in a group of sixteen patients with clinically confirmed pathological symptoms. We compared the results of neurophysiological tests recorded in patients with diagnosed TOS and healthy people.

Material and methods

The same tests of clinical neurophysiology have been conducted on 16 healthy subjects (control group) and 16 patients at the age

from 18 to 36. Patients with clinically confirmed TOS were qualified for the clinical neurophysiology diagnostic unit by the general practitioner. The inclusion criteria were pain in the upper limbs and neck, and the suspected TOS; the result of Doppler's imaging was always required. The exclusion criteria included pregnancy, an implanted pacemaker or a cochlear implant. Patients with confirmed degenerative changes in the cervical spine and after traffic accidents were also excluded from the study.

In both groups, before and after the test of "raised hands", there were performed neurophysiological studies. They included the examination of sensory perception with von Frey's filaments with reference to the dermatomal innervation, electromyography (sEMG) of chosen upper extremity muscles on both sides during maximal contraction lasting 5 seconds, electroneurography (ENG) of chosen nerves in upper extremities towards detection of changes in transmission of neural impulses in motor fibers, and motor evoked potentials (MEP) studies to detect the changes in efferent impulses transmission from the motor centers in C5-C7 neuromeres to the effectors.

Test of "raised hands" is the ischemic test lasting 2 minutes. A patient raises their hands over the head in half-elbow. The bilateral sEMG examinations from the abductor pollicis brevis, abductor digiti minimi and biceps brachii muscles during maximal contraction lasting 5 seconds were performed, and those before and after "raised hands" test twice from abductor pollicis brevis muscles. The decrease of EMG amplitude of more than 50% was ascertained as the positive ischemic tests indicating TOS. In the bilateral ENG examination, the values of the parameters of amplitudes and latencies of F and M potentials from the ulnar and median nerves were recorded. In MEPs, C5-C7 neuromeres were stimulated with the magnetic field at 1.3T, and motor potentials were recorded from abductor pollicis brevis, abductor digiti minimi and biceps brachii muscles on both sides.

The principles of neurophysiological methods used in this study are described elsewhere (Lisiński and Huber 2017, Huber and Lisiński 2019, Leszczyńska *et al.* 2019).

Results

Sensory perception in von Frey's filaments studies revealed changes in innervation more ulnar (10/16) than median nerves (6/16) in a group of patients. There were also detected decreased values of amplitudes of sEMG recordings (Figure 1A), especially after the test of "raised hands" of patients but not healthy subjects. Average amplitude in patients was recorded at 775 μ V and 1375 μ V in healthy subjects.

In more than 50% of patients, ENG results showed changes in the transmission of neural impulses in motor fibers of the ulnar nerves indicating the injury of the axonal type. MEP recordings, which were a novelty in comprehensive diagnostics of TOS, revealed "efferent blocks" in the motor impulses transmission above the Erb's point (Figure 1B) in more than 70% of patients but not in any of healthy subjects (Table 1).

Discussion

The main novelty of the presented study was an attempt to verify the diagnosis of TOS with the motor evoked potentials (MEP) method. We expected changes in the transmission of motor impulses from the cervical neuromeres following stimulation in patients with suspected TOS, and we have found the decrease of the MEP amplitude and increase of the MEP latency parameters in 70% of patients with clinically confirmed TOS. While diagnostic ENG is the standard neurophysiological method in TOS detection (Fernández-González and Suárez-Fernández 1998, Haghighi *et al.* 2005, Tolson 2004), the usefulness of the MEP has not been verified in the specialist medical literature presented in the PubMed database. The second issue undertaken in the project was the verification of transient changes in the activity of the motor units of the distal muscles of the upper

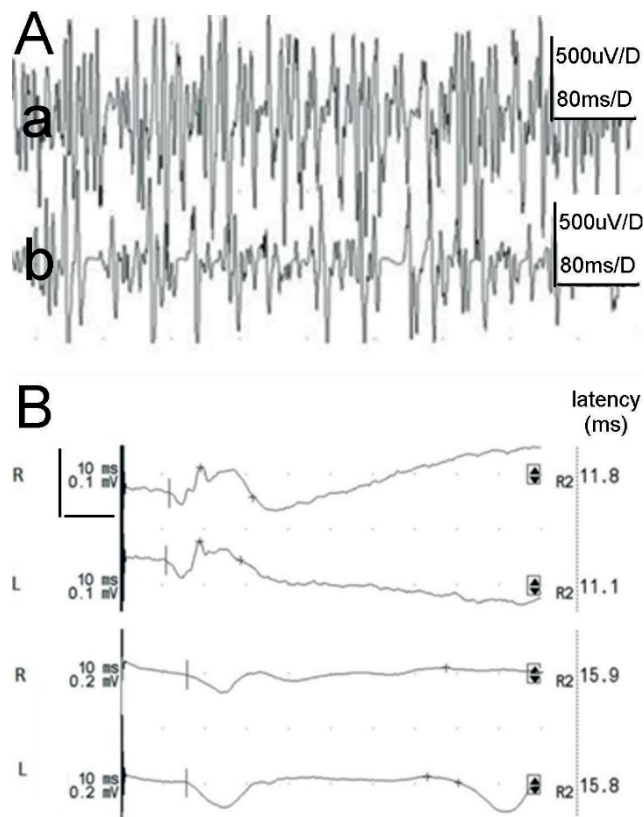


Figure 1. (A) Examples of sEMG recordings during the maximal contraction lasting 5 seconds from abductor pollicis brevis muscle before (a) and after (b) the test of "raised hands" in one of the patients with TOS. (B) Examples of MEP recordings from abductor pollicis muscles following the magnetic field stimulation oververtebrally at C5 recorded on both sides in one of the healthy subjects (two upper traces) and one of the patients with TOS for comparison. R-right, L-left.

Table 1. Results of sEMG, MEP and ENG studies in patients and healthy subjects. Mean values of amplitudes in µV and latencies in ms are presented.

Parameter	Healthy subjects	Patients	p
Site of recording			
sEMG			
Amplitude			
Before test of "raised hands"			
APB L	1337.0	1037.5	0.001297
APB R	1506.2	968.7	0.000007
sEMG			
Amplitude			
After test of "raised hands"			
APB L	1375.0	775.0	0.000005
APB R	1506.2	731.2	0.000000
MEP			
Amplitude	655.0	1285.5	0.000001
Latency	15.5	17.0	0.000001
ADM R			
ENG (M wave)			
Amplitude	4512	3850	0.000478
Latency	3.55	4.1	0.000093
Median nerve L			
ENG (M wave)			
Latency	3.56	4.1	0.000042
Ulnar nerve R			

Abbreviations: APB – abductor pollicis brevis muscle, ADM-abductor digiti minimi muscle, R-right, L-left, p – level of statistical significance

extremities following their ischemia when the application of the “raised hands” tests was introduced. For this purpose, we performed non-invasive surface electromyography (sEMG) studies in patients with suspected TOS after applying the test for 2 minutes. In sEMG recordings under the condition of maximal muscle contraction, a decrease in the recorded amplitude parameter is visible without changes in the frequency parameter of recruiting motor units by more than 50% compared to the test conducted before the ischemic test. Although the above-mentioned sEMG during the test of “raised hands” is an established diagnostic standard, its sensitivity and specificity in patients with clinically documented TOS have not been described so far. Our work aimed at refining the basic clinical diagnosis of thoracic outlet syndrome. Thanks to its results, patients will be able to start treatment much earlier to prevent the development of the disease. In the case of results indicative of a severe stage of TOS, the decision to use surgical treatment would be facilitated or abandoned depending on worsening or improving the subsequent clinical neurophysiology examinations.

Conclusions

MEP examination seems to be fast and specific test for confirmation of TOS symptoms regarding changes in motor impulses transmission in the brachial plexus motor fibers. The aim of this project was to indicate the usefulness of motor evoked potentials in comparison to other neurophysiological tests in the diagnosis of TOS. It is advisable to conduct research on a larger group of patients.

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