INDEX COPERNICUS INTERNATIONAL

The evaluation of the neck torsion test in subjective examinations of patients with vertigo and/or hearing loss

Ocena testu skrętu szyi w badaniach obiektywnych u chorych z zawrotami głowy i/lub niedosłuchem

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Piotr Niewiadomski [1AB], Hanna Zielińska-Bliźniewskaw[1F], Jarosław Miłońskiw[1CD], Piotr Pietkiewiczw[1D], Jurek Olszewskiw[1,2E]

[1] Clinic of Otorhinolaryngology, Laryngological Oncology, Audiology and Phoniatrics of the 2nd Otorhinolaryngology Department, Medical University in Łódź Head of the Department and the Clinic: Prof. Jurek Olszewski, PhD
[2] Department of Polish Dialectology and Laryngology, University of Łódź Head of the Department: Irena Jaros, PhD

Article history: Received: 09.09.2015 Accepted: 10.10.2015 Published: 30.10.2015

ABSTRACT:

Introduction. The aim of this work was to evaluate the diagnostic value of the neck torsion test in VNG, Doppler ultrasonography and brainstem auditory evoked potentials in patients with vertigo and/or hearing loss due to intracranial vascular malformations.

Material and methods. The study covered 47 patients, 30 female and 17 male (mean age, 55.5 years; range, 19-74 years) with vertigo and/or hearing disorders and the asymmetry of vertebral arteries. Each patient underwent a subjective examination, an otolaryngological examination, otoneurological diagnostics, VNG with gaze tracking in the straight ahead position and in the 600 left and right neck torsion, the neck torsion test, audiological diagnostics including I-, III- and V-wave latency of the brainstem evoked potentials in the straight ahead position and the right ear stimulation in the 600 right neck torsion and the left ear stimulation in the neck torsion to the left, Doppler ultrasonography with measuring the diameter of vertebral arteries and the velocity of the blood flow in these vessels with the use of the neck torsion test.

Results. In own study, in VNG, the positive neck torsion test was observed in 76.5% of the study patients, while square waves in both directions were found in 46.5% and in one direction in 10.6%. Cervical nystagmus was noticed in 19.1% of these patients. In the auditory evoked potentials test, the differences in I-, III- and V-wave latency time were not statistically significant, either at rest or in the neck torsion. In the Doppler ultrasound examination, the asymmetry of vertebral arteries were present (below 25%) in 7 women (14.9%) and 4 men (8.5%), whereas large asymmetries (above 25%) were observed in 23 women (48.9%) and 13 (27.7%) men (range, 25% - 215%) and was statistically insignificant.

The resting blood flow velocity in vertebral arteries of large asymmetries, both in systole and diastole heart phases, was significantly higher in the artery with larger asymmetry.

Conclusion. The neck torsion test can be diagnostically useful in monitoring the vertebrobasilar system as well as qualify for microsurgical procedures if the vertebrobasilar insufficiency has been diagnosed.

KEYWORDS: The neck torsion test, subjective examinations, vertigo and/or hearing lossKey words: neck torsion test, subjective examinations, vertigo and/or hearing loss

STRESZCZENIE:

Wstęp. Celem pracy była ocena wartości diagnostycznej testu skrętu szyi w badaniu VNG i ultrasonografii dopplerowskiej oraz słuchowych potencjałów wywołanych z pnia mózgu u chorych z zawrotami głowy i/lub zaburzeniami słuchu w przebiegu anomalii anatomicznych naczyń doczaszkowych.

DOI: 10.5604/00306657.1170412

Materiał i metody. Badaniami objęto 47 chorych, w tym 30 kobiet i 17 mężczyzn w wieku 19–74 lat (średnia wieku 55,5 lat) z zawrotami głowy lub/i zaburzeniami słuchu oraz asymetrią tętnic kręgowych. U każdego pacjenta przeprowadzono następujące procedury:

- podmiotowe i przedmiotowe badanie otolaryngologiczne,
- diagnostykę otoneurologiczną, w tym pełne badanie VNG z zapisem ruchów gałek ocznych w pozycji głowy na wprost oraz po skręcie głowy o 60˚ w prawo i w lewo, wykonane przy wykorzystaniu testu skrętu szyi,
- diagnostykę audiologiczną, w tym badanie czasu latencji fal I, III, V słuchowych potencjałów wywołanych z pnia mózgu w pozycji głowy na wprost, przy stymulacji ucha prawego podczas skrętu szyi o 60˚ w prawo, oraz ucha lewego przy analogicznym skręcie szyi w lewo,
- badanie USG metodą Dopplera z określeniem średnicy tętnic kręgowych oraz prędkości przepływu krwi w tych naczyniach z wykorzystaniem testu skrętu szyi.

Wyniki. Dodatni test skrętu szyi w badaniu VNG stwierdzono u 76,5% badanych. U 46,8% z nich zaobserwowano występowanie fal kwadratowych w obu kierunkach, u 10,6% – w jednym kierunku, u 19,1% chorych stwierdzono oczopląs pochodzenia szyjnego. W badaniu słuchowych potencjałów wywołanych różnicą czasu latencji fal I, III i V – tak w pozycji spoczynkowej, jak i podczas skrętu szyi – nie były istotne statystycznie. W badaniu USG metodą Dopplera asymetrię średnicy tętnic kręgowych bez istotnej różnicy (poniżej 25%) stwierdzono u 7 kobiet (14,9% badanych) i 4 mężczyzn (8,5% badanych). Natomiast dużą istotną asymetrię (od 25% do 215%) – u 23 kobiet (48,9%) i 13 mężczyzn (27,7%) i była ona statystycznie znamienna. Prędkość przepływu krwi w tętnicach kręgowych w badaniu spoczynkowym u chorych z dużą asymetrią tętnic, zarówno w fazie skurczowej jak i rozkurczowej, była wyraźnie wyższa po stronie większej średnicy tętnicy.

Wnioski. Test skrętu szyi może mieć znaczenie diagnostyczne przy badaniu wydolności układu kręgowo-podstawnego, lub kwalifikacyjne do leczenia mikrochirurgicznego – w przypadku stwierdzenia jego niewydolności.

SŁOWA KLUCZOWE: test skrętu szyi, badania obiektywne, zawroty głowy i/lub niedosłuch

INTRODUCTION

The sense of balance and spatial cognition is based on proper function of the balance system and correct connection between them. Good perfusion is one of the crucial conditions for proper functioning of the balance system.

Based on data collected between 2007 and 2012 by the Department of Laryngology, Laryngological Oncology, Audiology and Foniatry, Medical University in Łódź from 2167 patients, diagnosed due to vertigo and hearing disorders [1], anomalies of cranial vessels were found in 29 patients (1.3 %). Confirmed malformations included: hypoplasia of the right vertebral artery, hypoplasia of the left vertebral artery, hypoplasia of the right internal carotid artery, hypoplasia of the left internal carotid artery, hypoplasia of the right common carotid artery, and hypoplasia of the left subclavian artery. In addition, less common anomalies of the cranial vessels such as: aplasia of one of the vertebral arteries, vertebral arteries arising from the aortic arch or the common carotid artery, double origin of one vertebral artery connecting into the common trunk penetrating into foramina of transverse processes, and vertebral artery duplication, were discovered. According to other reaserchers, the aforementioned anomalies might be more common than described above [2-5].

Diagnostics of anomalies is problematic due to unspecific symptoms and concomitant systemic diseases which might cause similar complaints. Therefore, looking for better diagnostic procedures is justified. This will help accurately select patients for further diagnostics and make the correct diagnosis [10-11].

The study aimed to evaluate the diagnostic value of the neck torsion test in VNG, Doppler ultrasound and brain stem auditory evoked potentials in patients suffering from vertigo and/or hearing disorders.

MATERIALS AND METHODS

The study was conducted in 47 patient, including 30 women and 17 men aged from 19 to 74 years (mean age 55.5 years) with vertigo and/or hearing disorders and asymmetry of vertebral arteries. All patients underwent otolaryngological examination, subjective examination, VNG with gaze tracking in straight ahead position and in the 60^0 left and right neck torsion, using the neck torsion test. Outcomes were recorded for at least 30 s in every position, with 5-minute breaks between position changes.

Afterwards, auditory evoked potentials were tested. A "bang" with an intensity of 80 dB was used for stimulation. Latency

time for waves: I, III and V was used for measuring variation. The examination was performed with a head straight for 2000 introduced and accepted stimuli and with stimulation of the right ear during neck torsion test towards the right and with the stimulation of the left ear, respectively.

The diameter of vertebral arteries and the blood flow velocity were evaluated using Doppler ultrasound in the head straight position and for every vessel during the neck torsion test towards both sides. The patients were assigned to two groups, depending on the level of diameter asymmetry of the vertebral artery, assessed using the following formula.

Level of diameter asymmetry= $[(W_s - W_w)/W_w] \times 100\%$, W_s–larger diameter and W_w-smaller diameter. The first group with asymmetry <25% and the second, with asymmetry >25% found statistically significant [4]. Obtained results were analyzed evaluating arithmetic mean (X) and standard deviation (SD). The Mann–Whitney U test was used. The results were determined as statistically significant when a significance rate amounted to $p < 0.05$.

RESULTS

In the VNG record, 23 patients were diagnosed with a vestibular deficit above normal level (above 15%) which constituted 48.9 % of the evaluated population. However, this disorder was compensated. The comparison of caloric test results in VNG with Doppler ultrasound reports revealed that the side affected by a vestibular deficit correlated with a diameter of the vertebral artery in 15 patients (31.9%).

The neck torsion test in the evaluated group (Tab. I) revealed square wave in two directions in 22 patients (46.8%), one-direction square wave in 5 patients (10.6%), and cervical nystagmus in 9 patients (19.1%)

The auditory evoked potential record revealed a prolonged latency in wave I, III, and V in most of the patients during the neck torsion test in comparison to the initial position, whereas, the largest increase in latency and the most significant morphology deviations such as amplitude decrease up to a total decline, was observed for wave I, which corresponded with conduction in the distal part of the acoustic nerve (Tab. II). Latency increase in wave I, III and V was not statistically significant (p>0.05).

In Doppler ultrasound, insignificant asymmetry in the diameter of vertebral arteries (below 25%) was diagnosed in 7 women (14.9%) and 4 men (8.5%); whereas, large significant asymmetry (above 25%), ranging from 25% to 215%, was found in 23 women (48.9%) and in 13 men (27.7%).

Changes of the absolute value of diastolic and systolic blood flow velocity ranging from 12 cm/s to 20 cm/s in both verte-

Tab. I. Eye movement record in the neck torsion test in VNG in the studied patients (n=47).

STUDIED PARAMETERS	WOMEN		MEN		TOTAL	
	N	%	N	%	N	%
Square waves in both directions of the test	14	29,8	8	17,0	22	46,8
Square waves in one direction of the test	4	8,5	1	2,1	5	10,6
Nystagmus	4	8,5	5	10,6	9	19,1

Tab. II. Auditory evoked potentials record in the neck torsion test in the studied patients (n=47).

STUDIED PARAMETERS	RIGHT EAR (RE)		LEFT EAR (LE)		X		SD	
	N	%	N	%	RE	LE	RE	LE
Prolonged latency of the wave I (w ms)	26	55,3	36	76,6	0,23	0,21	0,4	0,3
Prolonged latency of the wave III (w ms)	26	55,3	26	55,3	0,17	0,21	0,2	0,3
Prolonged latency of the wave V (ms)	33	70,2	31	66,0	0,17	0,18	0,2	0,2

Tab. III. Mean velocity values (V max in cm/s) of the blood flow between right and left vertebral artery at rest and in the neck torsion test in the studied group (n=47).

STUDIED PARAMETERS	CONTRACTION VELOCITY		RELAXATION VELOCITY	
	X	SD	X	SD
Rest	6,55	0,75	4,4	0,41
Left torsion	8,0	1,15	5,5	0,64
Right torsion	9,25	1,36	5,5	0,62

Tab. IV. Mean velocity values (V_{max} in cm/s) of the blood flow between right and left vertebral artery at rest and in the neck torsion test in the studied group (n=47) in asymmetry <25%.

STUDIED PARAMETERS	CONTRACTION VELOCITY		RELAXATION VELOCITY	
	X	SD	X	SD
Rest	3,7	0,55	2,5	0,31
Left torsion	4,5	0,65	3,7	0,54
Right torsion	6,7	1,06	3,6	0,52

Tab. V. Mean velocity values (V_{max} in cm/s) of the blood flow between right and left vertebral artery at rest and in the neck torsion test in the studied group (n=47) in asymmetry >25%.

STUDIED PARAMETERS	CONTRACTION VELOCITY		RELAXATION VELOCITY	
	X	SD	X	SD
Rest	9,2	1,35	6,2	0,81
Left torsion	10,8	1,65	7,3	0,84
Right torsion	11,9	1,76	6,0	0,62

bral arteries were observed. Changes were more significant in the vessel for which the test was performed and depended on the arterial asymmetry level.

More clear data were obtained as a result of blood flow velocity analysis in the vessels located on the opposite sides (Tab. III).

The changes of blood flow velocity were presented in table IV and V in the context of the asymmetry level between vertebral artery diameters with patients divided into two groups and an asymmetry level below and above 25%. Calculated differences in patients with vertebral artery asymmetry level above 25% were statistically significant ($p<0.05$).

Further analysis included differences in blood flow velocity between vertebral arteries in the context of a dominating vessel. The vessel with a larger diameter was considered dominating. The results were presented in Table VI and VII.

DISCUSSION

The symptoms of anatomical anomalies are not characteristic enough to diagnose these disorders from the very beginning. Symptoms commonly present bilaterally. In addition, anatomical anomalies frequently coexist with other disorders which might cause similar symptoms in the head and neck, [12] such as: injuries, degenerative changes in the cervical region of the vertebral column, arterial hypertension, hormonal disorders and metabolic disorders. Due to this fact, many authors claim that anatomical anomalies are diagnosed when other causes interfere with previously functioning vessels of the central nervous system. For example, a higher incidence of vertebral artery hypoplasia is reported in women during menopause, who often present with symptoms of vertebrobasilar insufficiency [4].

At present, Doppler ultrasound is a very significant diagnostic method including: constant wave Doppler and color, pulsatile Doppler ultrasound. Perfect images are obtained with computed tomography, contrast angiography and magnetic resonance angiography [2,10,11].

Blood flow disorders in the cranial arteries might be caused by acquired sclerosis or as a result of congenital changes - vascular anomalies [1, 2, 4, 5]. Anomalies of vertebral arteries include hypoplasia of one of the vertebral arteries coexisting with a compensative widening of the opposite vertebral artery. However, vertebral arteries differ in diameter and usually the left vertebral artery is wider. Aplasia of one vertebral artery was also reported. The vertebral artery originating directly from the aorta or the common carotid artery and double origin of the vertebral artery, which combines into a common trunk were also reported. Very rarely, the vertebral arteries are duplicated on one side.

In own studies, a positive result of the neck torsion test was reported in 76.5% of the examined patients. In 46.8% of the subjects, two-sided square waves and in 10.6% one-sided square wave were observed. In 19.1% of the patients cervical nystagmus was reported.

Examining wave latency of the audial provoked potentials using the neck torsion test showed a different level of latency prolongation in most of the patients. The most significant changes were reported in the wave corresponding with stimulus conduction in the distal part of the audito-

Tab. VI. Mean velocity values (V_{max} in cm/s) of the blood flow between right and left vertebral artery (dominating left vertebral artery) at rest and in the neck torsion test in the studied group (n=47).

STUDIED PARAMETERS	CONTRACTION VELOCITY		RELAXATION VELOCITY	
	X	SD	X	SD
Rest	5,7	0,85	4,9	0,71
Left torsion	7,5	1,05	5,5	0,94
Right torsion	7,4	1,06	5,4	0,92

Tab. VII. Mean velocity values (V_{max} in cm/s) of the blood flow between right and left vertebral artery (dominating right vertebral artery) at rest and in the neck torsion test in the studied group (n=47).

STUDIED PARAMETERS	CONTRACTION VELOCITY		RELAXATION VELOCITY	
	X	SD	X	SD
Rest	8,7	0,95	4,7	0,51
Left torsion	9,6	1,25	5,9	0,84
Right torsion	12,6	1,46	6,5	0,92

ry nerve and included the greatest latency prolongation, in comparison to other waves, and morphology changes presented as amplitude decrease up to almost a total record decline.

Using the neck torsion test in ultrasound assessment of the vertebral arteries, significant changes in the blood flow velocity were found between the vessels presented as a velocity increase, whereas, this increase was larger in significant asymmetry of vertebral arteries (>25%). In case of vertebral artery asymmetry, the larger increase in the blood flow velocity difference was observed during the test performed on the vessel with a larger diameter.

In case of advanced vertebrobasilar insufficiency accompanied by life-threatening neurological symptoms, intracranial or extracranial microsurgical treatment is necessary.

According to researchers, hypo-perfusion of the posterior cranial fossa, as a result of blood flow disorders in the vertebrobasilar system, caused by metabolic changes and anomailites in the vessels leads to dysfunction of the balance system and/or hearing loss [14-16]. Therefore, functional diagnostic tests are necessary including the neck torsion test.

CONCLUSIONS:

1. The neck torsion test might be useful for assessment of the vertebrobasilar system efficiency or to qualify the patient for microsurgery in case of vertebrobasilar insufficiency.

REFERENCES

1. Miłoński J., Kuśmierczyk K., Mielczarek M., Niewiadomski P., Olszewski J., Anomalia anatomiczne tętnic doczaszkowych u chorych z zawrotami głowy i zaburzeniami słuchu. Otolaryngol Pol 2013; 67(20): 77–81.
2. Drobisz A. T., Herfurt W., Zespół kręgowo-podstawny i inne patologie tętnic kręgowych w ocenie dopplerowskiej. Udar Mózgu 2001; 3(1): 35–41.
3. Poona M., Singla R. K., Sharma T., Incidence of anomalous origins of vertebral artery – anatomical study and clinical significance. J Clin Diag Res. 2010; (4): 2626–2631.
4. Mysior M., Majos A., Grzelak P., Szubert W., Stachowiak S., Stefańczyk L., Hypoplazja tętnicy kręgowej a objawy niewydolności kręgowo-podstawnej u kobiet w wieku menopauzalnym. Przegląd Menopauzalny 2007; 5: 298–302.
5. Paksoy Y., Vatansev H., Seker M., Ustun M.E., Buyukmumcu M., Akpinar Z., Congenital morphological abnormalities of the distal vertebral arteries (CMA-DVA) and their relationship with vertigo and dizziness. Med Sci Monit. 2004; 10(7): 316–323.
6. Olszewski J., Majak J., Pietkiewicz P., Łuszcz C., Repetowski M., The association between positional veretebral and basilar artery flow lesion and prevalence of vertigo in patients with cervical spondylosis. Otolaryngol-Head and Neck Surg. 2006; 134: 680–684.
7. Olszewski J., Zalewski P., Machała Z., Gaszyński W., Zastosowanie testu skrętu szyi przy badaniu prędkości przepływu krwi metodą dopplerowską w układzie tętnic kręgowych i podstawnej mózgu u osób ze zmianami zwyrodnieniowymi odcinka szyjnego kręgosłupa. Otolaryngol Pol 1994; 68(6): 549–555.
8. Majak J., Olszewski J., Miłoński J., Kuśmierczyk K., Ocena wpływu czynnościowych zaburzeń prędkości przepływu w tętnicach kręgowych i w tętnicy podstawnej na występowanie zawrotów głowy u pacjentów ze zmianami zwyrodnieniowymi odcinka szyjnego kręgosłupa. Pol Merk Lek 2005; 111: 398–399.
9. Soustiel J.F., Shik V., Shreiber R., Tavor Y., Goldsher D., Basilar vasospasm diagnosis: investigation of a modified „Lindegaard Index" based on imaging studies and blood velocity measurements of the basilar artery. Stroke 2002; 33(1): 72–77.
10. Acar M., Degirmenci B., Yucel A., Albayrak R., Haktanir A., An evaluation of internal carotid artery and cerebral blood flow volume using color duplex sonography in patients with vertebral artery hypoplasia. Eur J Radiol 2005; 53: 450–453.
11. Satomura S., Study of the flow patterns in the peripherial arteries by ultrasonic. J Acoust Soc Japan 1995; 15: 151–158.
12. Strupp M., Planck J.H., Arbusow V., Steiger J., Bruckmann H., Brandt T., Rotational vertebral artery occlusion syndrome with vertigo due to „labyrinthine excitation". Neurology 2000; 28(6): 1376–1379.

13. Hopkins L.N., Martin N.A., Hadley M.N., Spetzler R.F., Budny J., Carter L.P., Vertebrobasilar insufficiency. Part 2. Microsurgical treatment of intracranial vertebrobasilar disease. J Neurosurg 1987; 66(5): 662–674.
14. Lee H., Recent advances in acute hearing loss due to posterior circulation ischemic stroke. J Neurol Sci. 2014; 15(1–2): 23–29.
15. Choi J.H., Seo J.D., Kim M.J., Choi B.Y., Choi Y.R., Cho B.M., Kim J.S., Choi K.D., Vertigo and nystagmus in orthostatic hypotension. Eur J Neurol. 2015; 22(4): 648–655.
16. Di Berardino F., Alpini D.C., Bavera P.M., Cecconi P., Farabola M., Mattei V., Ambrosetti U., Cesarani A., Chronic cerebrospinal venous insufficiency in Ménière disease. Phlebology. 2015; 30(4): 274–279.

Word count: 2250 Tables: 7 Figures: – References: 16

Access the article online: DOI: 10.5604/00306657.1170412 Full-text PDF: www.otolaryngologypl.com/fulltxt.php?ICID=1170412

Corresponding author: Prof. Jurek Olszewski, MD; Clinic of Otorhinolaryngology and Oncological Laryngology, Otorhinolaryngology Department, Medical University in Łódź; ul. Żeromskiego 113, 90-549 Łódź; phone no.: +4842 639 35 80, fax +4842 639 35 80; e-mail: jurek.olszewski@umed.lodz.pl

Funding: Research conducted under grants for young scientists no. 502-03/7-061-01/502-54-138

Competing interests: The authors declare that they have no competing interests8

Cite this article as: Niewiadomski P., Zielińska-Bliźniewska H., Miłoński J., Pietkiewicz P., Olszewski J.: The evaluation of the neck torsion test in subjective examinations of patients with vertigo and/or hearing loss. Otolaryngol Pol 2015; 69 (5): 16-21