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ORIGINAL ARTICLE

Posturography studies in patients with central and mixed vertigo Summary

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Article history: Received: 20.10.2017 Accepted: 27.11.2017 Published: 30.06.2018

ABSTRACT:

Introduction: The aim of the study was to compare the results of posturography in patients with central and mixed vertigo.

Material and methods: 50 patients (40 female and 10 male) aged between 26-47 complaining of vertigo were examined during their hospitalization in the Department of Otolaryngology, Laryngological Oncology, Audiology and Phoniatrics, Medical University of Lodz in 2014. The subjects were divided into two groups: I – 26 patients (23 female and 3 male) with central vertigo, II – 24 patients (17 female and 7 male) with mixed vertigo. The control group (III) consisted of 26 subjects, students and graduates of Lodz Universities, aged from 19 to 30, that did not complain of vertigo. The subjects were qualified to particular groups based on videonystagmography results. The examinations were conducted with "BioSway portable balance system" by Biodex.

Results: In tests on a stable surface, with both closed and opened eyes, subjects with mixed vertigo coped slightly better. In tests on a sponge surface, subjects with central vertigo coped better. Conclusions: Based on the conducted research, it may be concluded that the ability to keep balance in subjects with central and mixed vertigo is on average three times lower than in population not suffering from vertigo episodes.

KEYWORDS: posturography, central vertigo, mixed vertigo

INTRODUCTION

According to the assessment, the problem of vertigo affects 20-30% of adults in reproductive age and 8-18% of children, of whom 7-10% of adults report recurrent vertigo.

It is difficult to unambiguously define vertigo as these symptoms are described with extreme ambiguity. When taking medical history from the patient one can hear various descriptions of the symptoms which in Polish have only one dictionary entry "vertigo" ("zawroty głowy"). This led to the development of many classifications of vertigo [1, 2].

Laryngologists are assumed to be responsible for the diagnosis and treatment of peripheral vertigo, as it is usually caused by: benign paroxysmal positional vertigo, Meniere's disease, vestibular neuritis, ototoxic substances etc. Central vertigo is on the other hand within the competence of neurologists as it is generally caused by: angiogenic CNS disorders, sequelae of brain traumas, brain tumors, multiple sclerosis, paroxysmal disorders (e.g. epilepsy, migraine), CNS inflammation [1].

There are many methods of balance system examination which are often on the border of laryngology and neurology. It is important to, if possible, diagnose the patients in a multi-profile hospital which gives a possibility to quickly conduct multidisciplinary consultations and additional examinations. The aim of diagnostic proceedings is to define the probable causes and characteristic features for the given type of vertigo, and next to establish and initiate appropriate treatment, according to the current standards. Methods of examination of the balance system are used not only for diagnosing symptoms, but also for prophylaxis and case-law [3-6].

One of the methods of examining the balance system is multisensory posturography, also called an objective Romberg's test [4, 7-11]. It allows for the evaluation of postural and ve-

Tab. I. Results of the general postural stability test in examined subjects.

GROUP	MINIMAL VALUE	MAXIMAL VALUE	MEAN	SD	MEDIAN
I - Central vertigo	0,2	2,1	0,87	0,32	0,8
II - Mixed vertigo	0,1	1,8	0,82	0,34	0,7
III - Healthy subjects	0,1	0,6	0,26	0,04	0,2

Tab. II. Results of the stability index A/P in postural stability test in examined subjects.

GROUP	MINIMAL VALUE	MAXIMAL VALUE	MEAN	SD	MEDIAN
I - Central vertigo	0,2	1,7	0,69	0,33	0,7
II - Mixed vertigo	0,1	1,4	0,65	0,24	0,55
III - Healthy subjects	0,1	0,4	0,2	0,03	0,2

Tab. III. Results of the stability index M/L in postural stability test in examined subjects.

GROUP	MINIMAL VALUE	MAXIMAL VALUE	MEAN	SD	MEDIAN
I - Central vertigo	0	1,0	0,35	0,13	0,3
II - Mixed vertigo	0	1,0	0,37	0,14	0,3
III - Healthy subjects	0	0,5	0,11	0,02	0,1

Tab. IV. Results of the postural stability test as a % of time in given zones in examined subjects

GROUP	ZONE	MINIMAL VALUE	MAXIMAL VALUE	MEAN	MEDIAN
I - Central vertigo	A	93%	100%	99.42%	100%
	B	0%	6%	0.54%	0%
	C	0%	1%	0.04%	0%
	D	0%	0%	0%	0%
II - Mixed vertigo	A	96%	100%	99,75%	100%
	B	0%	3%	0,21%	0%
	C	0%	1%	0,04%	0%
	D	0%	0%	0%	0%
III - Healthy subjects	A	100%	100%	100%	100%
	B	0%	0%	0%	0%
	C	0%	0%	0%	0%
	D	0%	0%	0%	0%

stibulospinal reflex disorders, and the whole balance system is involved in its conduction.

The working principle of posturography is registration of displacements of the projections of the center of gravity in relation to the surface of device platform thanks to measuring the directions of foot pressing forces. These displacements are a result of body leveling off reactions performed in the standing position. What is more, also symmetry of weighing down specific low extremities can be measured. Additionally, to increase difficulty, additional variants of the examination can be introduced, e.g. with closed eyes, with head torsion, standing on one foot.

There are two diagnostic methods: static and dynamic posturography, conducted on the one- or two-platform devices.

Obtained data are saved on the computer as graphs, called stabilograms, located on the coordinate axis, which are registrations of the projection of body center of gravity in time. It is essential to initially provide the software with information about patient's height and weight. Quantitative evaluation of the graphic recording is also possible, with the use of assessment of e.g. radius of displacements, length of the distance covered, displacement velocity, total surface area, coordination index, Romberg index, or results of the electromyographic recording: latency, frequency, amplitude, and surface area of postural muscle tensions.

The aim of the study is to perform a comparative analysis of the results of posturographic examination in patients with vertigo of central and mixed origin.

MATERIAL AND METHODS

Fifty patients (40 women and 10 men) aged from 26 to 77 years (mean age 59.5 years), hospitalized in the Otolaryngology, Laryngological Oncology, Audiology and Phoniatrics Clinic of the "WAM" Clinical Hospital in Lodz in 2014 due to vertigo were enrolled in the study. The patients were divided into two groups:

- I- 26 patients (23 women and 3 men) aged from 28 to 77 years (mean 61.6 years), with vertigo of central origin,
- II- 24 patients (17 women and 7 men) aged from 26 to 77 years (mean 56.4 years), with vertigo of mixed origin.
- Control group (III) included 26 subjects aged from 19 to 30 years (mean age 24.4 years) who were students or graduates of colleges in Lodz, with no history of vertigo.

The examined subjects were qualified to given groups on the basis of the videonystagmographic examination. The examination was performed with the use of "BioSway portable balance

Tab. V. Results of the clinical test of sensory integration and balance with eyes open (stable surface) in examined subjects.

GROUP	MINIMAL VALUE	MAXIMAL VALUE	MEAN	SD	MEDIAN	NORM	RESULTS IN THE NORMAL RANGE AND BELOW
I - Central vertigo	0.27	2.33	0.96	0.36	0.82		23%
II - Mixed vertigo	0.27	2.43	0.83	0.31	0.69	0.21-0.48	20%
III - Healthy subjects	0.14	0.72	0.29	0.15	0.26		92%

Tab. VI. Results of the clinical test of sensory integration and balance with eyes closed (stable surface) in examined subjects.

GROUP	MINIMAL VALUE	MAXIMAL VALUE	MEAN	SD	MEDIAN	NORM	RESULTS IN THE NORMAL RANGE AND BELOW
I - Central vertigo	0.41	4.03	1.50	0.49	1.18		31%
II - Mixed vertigo	0.33	3.43	1.33	0.38	1.07	0.48-0.99	44%
III - Healthy subjects	0.27	1.2	0.53	0.18	0.47		96%

Tab. VII. Results of the clinical test of sensory integration and balance with eyes open (foam surface) in examined subjects.

GROUP	MINIMAL VALUE	MAXIMAL VALUE	MEAN	SD	MEDIAN	NORM	RESULTS IN THE NORMAL RANGE AND BELOW
I - Central vertigo	0.7	2.83	1.51	0.48	1.41		4%
II - Mixed vertigo	0.78	4.33	1.58	0.53	1.37	0.38-0.71	0%
III - Healthy subjects	0.5	0.87	0.68	0.21	0.68		60%

Tab. VIII. Results of the clinical test of sensory integration and balance with eyes closed (foam surface) in examined subjects.

GROUP	MINIMAL VALUE	MAXIMAL VALUE	MEAN	SD	MEDIAN	NORM	RESULTS IN THE NORMAL RANGE AND BELOW
I - Central vertigo	1.24	5.36	3.15	0.83	3.14		12%
II - Mixed vertigo	1.56	6.54	3.67	0.99	3.46	1.07-2.22	12%
III - Healthy subjects	1.06	2.45	1.71	0.54	1.71		92%

system" by Biodex. It is a light, portable, and compact posturograph, whose preparation to work takes a few minutes. It has six modes of training and three standardized built-in tests, which constitute a credible, reproducible and objective tool for the diagnosis and rehabilitation of the balance system. This device may also be successfully used during prosthetic, orthopedic, post-traumatic and muscular rehabilitation.

The tests were conducted once, in the morning hours. Before commencing the diagnostics, the patient was precisely informed about the aim and the course of the examination, according to the recommendations described by the manufacturer in the posturography instruction. The investigator introduced personal data of the examined patient to the software, with information about the age and height, thanks to which the device could properly measure the displacements of the center of gravity located at approximately 55% of human height. Then the patient was walking onto the posturography platform and obeying investigator's instructions. The patient's ability to maintain stability was examined using the postural stability test. The patient undergoes three tests, lasting 20 seconds each, with a break of over a dozen seconds between them. Computer automatically chooses and saves the best result. Evaluation is based on a scoring depending on the number of displacements of the center of gravity, and, in consequence, the lower the result, the better the patient's performance [27].

Performed test of sensory integration and balance served as a standard tool for differentiation of visual, vestibular and somatosensory causes of balance disorders and comprised four phases: eyes open, stable surface (basic conditions, healthy subjects are very stable, stimuli are received by vestibular, vision, and proprioceptive organs); eyes closed, stable surface (disabled visual stimulation, mainly proprioceptive organs' function, information from vestibules are a secondary source, healthy subjects do not have major problems with stability); eyes open, unstable surface – foam (greater involvement of function of the muscular system, visual stimuli are responsi-

ble for primary impulsation, vestibular stimuli act secondarily, the amplitude of displacements increases in healthy subjects); eyes closed, unstable surface – foam (the most demanding test for vestibular organ, deep sensation is disturbed by the unstable surface, and vision is disabled, healthy subjects lean with an increased amplitude, yet they do not fall),

The correctness of the functioning of the balance system is evaluated on the basis of results: the lower they are, the better. Additionally, the manufacturer provides normative data, accepted by IRB (Institutional Review Board – Bioethics Committee), conducted in the group of 100 healthy, active, working, randomly chosen subjects:

- eyes open, stable surface; 0.21-0.48,
- eyes closed, stable surface; 0.48-0.99,
- eyes open, unstable surface; 0.38-0.71,
- eyes closed, unstable surface; 1.07-2.22.

Obtained data were statistically analyzed with calculation of the following values: minimal, maximal, median and mean, and standard deviation.

RESULTS

In the performed total postural stability test mean values were observed as follows:

(Tab. I): in group I-0.87, in group II-0.82 and in group III-0.26.

The examined mean index of stability A/P in this test was (Tab. II): in group I- 0.69, in group II- 0.65 and in group III-0.2, accordingly.

The analyzed mean index of stability M/L in postural stability test was as follows (Tab. III): in group I- 0.35, in group II-0.37 and in group III-0.11.

All subjects from the control group remained in the region of area A (Tab. IV) during whole testing time (20 s). Patients with central vertigo were in this zone on average for 99.42% of time (19.88 s), and with mixed vertigo for 99.75% of the examination time (19.95 s).

Discrete displacements to zone B and zone C were also noted in patients with central and mixed vertigo, as it is presented in Table IV.

Mean value of test of sensory integration and balance with eyes open (stable surface) in examined patients was as follows (Tab. V): in group I- 0.96, in group II- 0.83 and in group III-0.29. Results in normal range were obtained by 92% subjects from control group and 23% patients with central vertigo and 20% with mixed vertigo.

On the other hand, mean value of results of the test of sensory integration and balance with eyes open (foam surface) in examined patients was as follows (Tab. VI): in group I- 1.50, in group II- 1.33 and in group III-0.53. Result in normal range was obtained by 94% subjects from control group and 31% patients with vertigo of central origin and 44% with vertigo of mixed origin.

Mean value of results of the test of sensory integration and balance with eyes closed (stable surface) in examined patients was (Tab. VII): in group I- 1.51, in group II- 1.58 and in group III-0.68. Normal results were obtained by 60% subjects from control group and only 23% patients with vertigo of central origin.

Mean value of results of test of sensory integration and balance with eyes closed (foam surface) in examined patients was as follows (Tab. VIII): in group I- 3.15, in group II- 3.67 and in group III-1.71. Normal results were obtained by 92% subjects from control group and 12% patients with vertigo of central origin and of mixed origin.

DISCUSSION

Posturography is widely applied in the diagnostics of stability. This follows from its ability to evaluate the balance system, postural reactions and risk of fall in an easy, holistic, objective and quantitative way, as well as to perform qualitative static--dynamic tests.

The basic form of examination is "Romberg's test", based on the measurement of stability in two thirty-second tests: first with eyes open (following a graphic presentation of the center of gravity on the screen), and second with eyes closed.

In authors' own research in case of tests on a stable surface, both with eyes open and closed, patients with vertigo of mixed origin managed slightly better.

Despite a more severe deficit of the balance system in these patients, this is a group with a lower mean age so their autonomous muscular strategies of balance (mainly ankle) and somatosensory impulsation in feet are better than in patients with vertigo of central origin, in whom biological ageing of muscular and neural tissue causes lower adaptive ability of motoric units of muscles during contractions and deep sensation [7, 10, 14].

Results of the test on the foam surface turned out to be more favorable in patients with vertigo of central origin.

It can be explained by the fact that this type of examination causes not only stimulation of balance strategies in muscles and proprioceptive sensation but also stimulation of labyrinths, in which major deficits are observed among patients with vertigo of mixed origin, absent in the second group with vertigo – due to frequent displacements from the state of equilibrium of linear and angular acceleration type.

Posturography can be not only static, but also dynamic. It can be conducted on specific devices which allow for the use of sudden, and unpredictable for the patient, moves of the ground. Balance disorders induced in this way enable registration of various types of balance strategies.

Posturographic tests are used not only during clinical diagnostics of the patients, but also during the analysis of weighing down the extremities, rehabilitation with the use of biofeedback, or sports trainings of balance.

Comparable research was carried out at the Medical University of Washington with similar results [13]. In the published results it was emphasized that caloric tests served better for detection of vertigo in the examined patients while posturography allowed for investigation of functional deficits of balance systems in a greater number of diagnosed participants of the tests.

It was found that the abnormalities in the results of caloric tests always correlate with vertigo while the defects of balance system functioning detected by posturography can be independent of them.

Caloric tests served also in diagnostics of vertigo in patients before posturographic tests, described in this publication. For the evaluation of the results of the carried out measurements the normative values of Clinical Test of Sensory Integration and Balance, attached to the instruction of BioSway portable balance system, were used. Due to the lack of available norms in literature for the results of postural stability test, results of the tests conducted in the control group (healthy subjects, not reporting episodes of vertigo) served as a reference to physiology.

The subject of posturographic measurements in vertigo is quite rarely raised in national and English literature which may speak for the novelty of this form of diagnostics [8, 9].

Posturography is used not only in otoneurological diagnostics, but also to control the course of a disease: its dynamics, treatment results, compensation processes, habituation, and effectiveness of rehabilitation. Yet, considerable price of the posturograph consitutes an important disadvantage [7-10].

CONCLUSIONS

1. In case of tests on a stable surface, both with eyes open and closed, patients with vertigo of mixed origin managed slightly better.

2. Th results of the test on a foam surface turned out to be more favorable in patients with vertigo of central origin.

3. Based on the conducted research, that ability to maintain balance in patients with central and mixed vertigo is on average threefold lower than in population of people not reporting episodes of vertigo.

REFERENCES

1. Litwin T, Członkowska A. Zawroty głowy w praktyce neurologa – diagnostyka i leczenie, Polski Przegląd Neurologiczny 2008; 4: 78-86.
2. Narożny W, Siebert J, Wojtczak R. Epidemiologia zawrotów głowy i zaburzeń równowagi, Forum Medycyny Rodzinnej 2010; 4(5): 356-65.
3. Prusiński A. Klasyfikacja, obraz kliniczny i leczenie zawrotów głowy, Polski Przegląd Neurologiczny 2011; (1): 11-19.
4. Olszewski J, Latkowski JB. Fizjoterapia w otorynolaryngologii. W: Olszewski J. (red.). Fizjoterapia w wybranych dziedzinach medycyny. Wydawnictwo PZWL, Warszawa 2011; 212-26.
5. Held-Ziółkowska M. Równowaga statyczna i dynamiczna ciała. Organizacja zmysłowa i biomechanika układu równowagi. Magazyn Otorynolaryngologiczny 2006; 5(2): 39-52.
6. Zamysłowska-Szmytke E, Śliwińska-Kowalska M. Badania układu równowagi dla potrzeb medycyny pracy. Otorynolaryngologia 2012; 11(4): 139-45.
7. Ocetkiewicz T, Skalska A, Grodzicki T. Badanie równowagi przy użyciu platformy balansowej - ocena powtarzalności metody. Gerontologia Polska 2006; 14(1): 144 - 8.
8. Olejarz P, Olchowik G. Rola dynamicznej posturografii komputerowej w diagnostyce zaburzeń równowagi. Otorynolaryngologia 2011; 10(3): 103-10.
9. Strzecha M i in. Stabilność i symetria obciążania kończyn dolnych w badaniu dwuplatformową wagą stabilograficzną. W: Mosiewicz J. (red.) Czynniki ryzyka i profilaktyka w walce i zdrowie i dobrostan. NeuroCentrum, Lublin 2008: 167 - 80.
10. PHU Technomex. Przenośny system balansowy BioSway. Instrukcja obsługi.

11. Timothy C. Hain, MD. moving platform posturography testing. Computerized Dynamic Posturography (CDP), Chicago 2017.
12. https://www.dizziness-and balance.com/testing/posturography.html .
13. Swami H et al. Comparative study between posturography and caloric test in balance disorders. Int J Otorhinolaryngol Head Neck Surg 2016; 2(4):168-73.
14. Budzińska K. Wpływ starzenia się organizmu na biologię mięśni szkieletowych. Gerontol Pol 2005; 13(1): 1-7.

Word count: 2170 Tables: 2 Figures: 3 References: 14

Access the article online: DOI: 10.5604/01.3001.0011.7256 Table of content: https://otolaryngologypl.com/issue/11199

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

Cite this article as: Fedorowicz J., Bielińska M., Olszewski J.; Posturography studies in patients with central and mixed vertigo Summary; Otolaryngol Pol 2018; 72 (3): 19-25