Nonrandomized Study

Tetra-ataxiometric Posturography in Patients with Migrainous Vertigo

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Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: This study was previously presented as a poster presentation in the 7th World Congress on Controversies in Neurology (CONy), in Istanbul, Turkey, on April 11 – 14, 2013.

Manuscript received: 10-10-2014
Revised manuscript received: 06-26-2014
Accepted for publication: 07-22-2015

Free full manuscript: www.painphysicianjournal.com

Background: Migraine is a common disorder characterized by headache attacks frequently accompanied by vestibular symptoms like dizziness, vertigo, and balance disorders. Clinical studies support a strong link between migraine and vertigo rather than between other headache types and vertigo or nonvertiginous dizziness. There is a lack of consensus regarding the pathophysiology of migrainous vertigo. Activation of central vestibular processing during migraine attacks and vasospasm-induced ischemia of the labyrinth are reported as the probable responsible mechanisms. Because vestibular examination alone does not provide enough information for diagnosis of migrainous vertigo, posturography systems which provide objective assessment of somatosensory, vestibular, and visual information would be very helpful to show concomitant involvement of the vestibular and somato-sensorial systems. There are few posturographic studies on patients with migraine but it seems that how balance is affected in patients with migraine and/or migrainous vertigo is still not clear. We want to investigate balance function in migraineurs with and without vertigo with a tetra-ataxiometric posturography system and our study is the first study in which tetra-ataxiometric static posturography was used to evaluate postural abnormalities in a well-defined population of patients with migrainous vertigo.

Objective: To investigate balance functions in migraineurs with and without vertigo with a tetra-ataxiometric posturography system.

Study Design: Prospective, nonrandomized, controlled study.

Setting: Pamukkale University Hospital, Neurology and Physical Therapy and Rehabilitation outpatient clinics.

Methods: Sixteen patients with migrainous vertigo, 16 patients with migraine without aura and no vestibular symptoms, and 16 controls were included in the study. Computerized static posturography system was performed and statistical analyses of fall, Fourier, Stability, and Weight distribution indexes were performed. The tetra-ataxiometric posturography device measures vertical pressure fluctuations on 4 independent stable platforms, each placed beneath 2 heels and toe parts of the patient; inputs from these platforms are integrated and processed by a computer digitally. Four separate plates are used and perpendicular pressures of the anterior and posterior feet are measured. Pressure of each force plate is measured and data was analyzed by the software program.

Limitations: A very small, non-randomized, and controlled study with the inability to find an answer to the mechanism of involvement of the somatosensorial system and vestibular system in migrainous headaches.

Results: The distribution of patients with posturographical abnormalities in the migrainous vertigo group was significantly different than the control group. Distribution of the patients with posturographical abnormalities in the high frequencies of the head-right position was significantly different in the migrainous vertigo group than in the control group and distribution of the patients with posturographical abnormalities in high frequencies of the head-right position was significantly different in the migraine group than in the controls groups. The stability index of the migrainous vertigo group was significantly higher than in the control group when tested on in the neutral-head position with open eyes.

Conclusion: In this first study of tetra-ataxiometric static posturography evaluating postural abnormalities in a well-defined population of patients with migrainous vertigo, the central part of the vestibular apparatus would be responsible of postural abnormalities in patients with migraine and migrainous vertigo.

Key words: Fall index, migraine, migrainous vertigo, static posturography

Pain Physician 2016; 19:E87-E95

Migraine is a chronic disorder, characterized by headache attacks and central nervous system autonomic dysfunction as defined by the International Headache Society (IHS), with a prevalence of 15 – 17% in women and 5 – 8% in men (1). Patients with migraine frequently report vestibular symptoms like head motion intolerance, unsteadiness, dizziness, and vertigo (1,2). Clinical studies in the general population support a link between migraine and vertigo and the studies in patients with migraine suggest a stronger association between migraine and vertigo than between other headache types and vertigo or nonvertiginous dizziness (3,4).

The pathophysiology of migrainous vertigo is not clear and activation of central vestibular processing during migraine attacks and vasospasm-induced ischemia of the labyrinth are reported as the probable responsible mechanism (5).

It is reported that neuro-otologic abnormalities can be seen in both migraineurs who complain of dizziness and migraineurs who do not complain of dizziness (4). So, only neuro-vestibular examination would not be proficient in patients with migraine and dizziness. For this reason various function tests have been used to evaluate the vestibular system in patients with migraine (1,3,5-8). One of these function tests, "posturography," is a new subject area. There are few posturographic studies on patients with migraine (6-10) and migraine is found to be associated with a slight but significant postural instability of central vestibular origin. However selection criteria of the patients and the type of posturographical evaluation are different in those studies. Akdal et al (2) evaluated findings of static posturography in patients with migraine but without migrainous vertigo and they found postural instability of central vestibular origin in migraineurs. However, in a study of Teggi et al (1), which is performed in patients with migrainous vertigo, it is stated that vestibular functional damage may occur in both central and peripheral pathways. In addition Çelebisoy et al (6) reported that peripheral vestibular dysfunction was more common than a central deficit in patient with migrainous vertigo. So, it seems that how the balance is affected in patients with migraine and/or migrainous vertigo is still not clear and there is a need for new research in well selected patient groups to clarify the possible pathogenesis of vestibular complaints in patients with migraine. The tetra-ataxiometric posturography system allows the clinician to evaluate all systems responsible for control of posture and balance simultaneously (6-10). As the vestibular tests require a long time, the simultaneously evaluation of the systems which are working together increases the chance of detecting the main pathology. In addition, this tool has not been used to evaluate migraine patients before and it would give additional information about the pathophysiological processes of vestibular symptoms in migraine. With this purpose we want to investigate balance function in migraineurs with and without vertigo with the tetra-ataxiometric posturography system which provides an objective assessment of somatosensory, proprioceptive, vestibular, and visual information.

Methods

Patients

The study was conducted in the Pamukkale University Medical School Department of Neurology, Denizli, Turkey. The study protocol was approved by the local ethics committee. Informed consent was obtained from all the participants. The study was designed as a prospective, nonrandomized, controlled study. All examinations and tests were performed in the hospital Neurology and Physical Therapy and Rehabilitation outpatient clinics. Patients with the diagnosis of migraine without aura (M) and migrainous vertigo (MV) were assessed. The diagnosis of migraine was based on the IHS criteria (11). The diagnosis of MV was based on the criteria of Neuhauser and Lempert (12). None of the patients had associated cochlear symptoms or were in an acute or postdromal phase of a migraine attack. Exams were performed at least 2 weeks after either a migrainous or vertiginous episode. Patients with any evidence of otological disease and any disease of the central nervous system other than migraine were excluded from the study. All patients underwent a detailed neuro-otological examination including searching for spontaneous nystagmus, head-shaking test, head-thrust test, and the Dix-Hallpike maneuver, and magnetic resonance imaging (MRI) of the brain, and patient with any pathological finding on those examinations (2 patients) were excluded. None of the patients were using any sedative drugs or tobacco within 24 hours before the examination. In addition patients suffering from any visual complaint were excluded from the study and the posturographical tests were performed on the all participants at the same hour of the day to exclude fatigue factor.

Sixteen patients fulfilling the criteria of MV and 16 patients with migraine without aura and no vestibular symptoms were included in the study. Sixteen healthy non-migrainous volunteers (mostly volunteered medical stuff) without a history of a vertiginous attack or balance disorder included as the control group (C).

All migraineurs and controls were women and the mean age of the MV group was 33.0 ± 8.5 (Mean ± SD), the mean age of the M group was 29.2 ± 8.0, and the mean age of C group was 30.3 ± 5.7, and the differences were statistically insignificant ($P > 0.05$). Mean duration of headaches was 11.2 ± 8.0 years in the MV group and 5.5 ± 5.2 years in the M group. The ratio of patients with more than 2 migraine attacks per month was 68.75% (n = 11) in both groups. The mean value of duration of vestibular symptoms was 2.8 ± 2.0 years in the MV group and 37.5% of these patients were complaining about true vertigo episodes while 62.5% were complaining about non-vertiginous dizziness episodes.

Equipment

Static posturography Tetrax® (Sunlight Medical Ltd., Ramat Gan, Israel) was used. The Tetrax static posturography device has a computer and software system, and all the data obtained from the device were the results of the software. The device measures vertical pressure fluctuations on 4 independent stable platforms, each placed beneath the 2 heels and toe parts of the patient; inputs from these platforms are integrated and processed by a computer digitally. Before the task, the patients were instructed to place their feet side by side on lined places on the platform in shape of feet, and not to speak or move during the task. Four separate plates are used and perpendicular pressures of the anterior and posterior feet are measured. Pressure of each force plate is measured and data was analyzed by the Tetrax® software program.

There are postures in static posturography:

1. Normal-eyes open: Normal neutral position, with open eyes. The patient positions his or her feet on the plates and stands for 32 seconds.
2. Normal-eyes closed: Same position as normal-eyes open but closed eyes limit the effect of vision, so effects of somatic sense or the vestibular organ may be specifically tested.
3. Head right: The patient positions his or her feet on the plates and stands for 32 seconds rotating the head 45° to the right. This posture helps to eliminate visual system and vestibular stress.
4. Head left: The patient positions his or her feet on the plates and stands for 32 seconds rotating the head 45° to the left. This posture helps to eliminate visual system and vestibular stress.
5. Head back: The patient positions his or her feet on the plates and stands for 32 seconds tilting the head back 30° and facing the ceiling (head back posture). This posture helps to eliminate visual, vestibular, and cervical stress.
6. Head forward: The patient positions his or her feet on the plates and stands for 32 seconds bending the head forward 30° and facing the floor (head forward posture). This posture helps to eliminate visual, vestibular, and cervical stress.
7. Pillow-eyes open: The patient positions his or her feet on a blue foam rubber pillow on the floor of the machine with open eyes. This posture limits the interference of somatic senses, stressing the effect of eyesight in maintaining stability and helps to eliminate the somatosensory system.
8. Pillow-eyes closed: The patient positions his or her feet on a blue foam rubber pillow on the floor of the machine with closed eyes. This posture limits the input of both the visual and somatic senses, thereby putting stress on the vestibular organ and helps to eliminate the somatosensory and visual system.

Table 1 shows the definitions of the 8 different positions and related anatomical structures.

After posturography, fall index, Fourier index, the stability index, and weight distribution index were measured.

1. Fall index: This score is globally calculated on the computer system's data of a patient's stability, Fourier transformation, and synchronization results. Fall risk calculated by considering the oscillation velocities computed by posturographic software was recorded for all the patients. Zero indicates no risk of falling and 100 indicates that it is extremely likely that the patient will fall. Fall index can be graded according to following groups: low (0 – 35), moderate (36 – 57), and high (58 – 100) risk of falling (13-14).
2. Fourier index: The Fourier index is a regression analysis of the postural sway intensity through Fourier transform, which shows a different frequency for each lesion that causes instability. It comprises 4 independent wave signals and subdivided into 8 band frequencies (0.01 to 0.1, 0.1 to 0.25, 0.25 to 0.35, 0.35 to 0.5, 0.5 to 1, 1 to 3, and 3 Hz and more) F1 to F8. Fourier frequencies from 0.01 to

Table 1. *Definitions of 8 different positions and related anatomical structures.*

Positions	Head Position	Eyes	Ground	Purpose
normal-eyes open	Neutral	Open	Solid	Neutral position
normal-eyes closed	Neutral	Closed	Solid	Elimination of visual system
pillow-eyes open	Neutral	Open	Elastic	Elimination of somatosensory system
pillow-eyes closed	Neutral	Closed	Elastic	Elimination of somatosensory and visual system
head right	Rotated to the right	Closed	Solid	Elimination of visual system and vestibular stress
head left	Rotated to the left	Closed	Solid	Elimination of visual system and vestibular stress
head back	Reclined	Closed	Solid	Elimination of visual, vestibular, and cervical stress
head forward	Inclined	Closed	Solid	Elimination of visual, vestibular, and cervical stress

Table 2. *Risk of falling in M, MV, and C groups.*

Groups	Fall Risk		
	Low (n – %)	Medium (n – %)	High (n – %)
M	7 – 43.75%	6 – 37.5%	3 – 18.75%
MV	11 – 68.75%	2 – 12.5%	3 – 18.75%
C	13 – 81.25%	3 – 18.75%	0

M: Migraineurs. MV: Migrainous vertigo. C: Controls

0.1 Hz are classified as low frequencies (F1), which are related to visual control, and associated with a normal position and comfortable posture. A higher index for the frequency indicates a larger instability (13).

3. Stability index: Stability index based on the assessment of replacement of the gravity center from each of the 4 platforms. General stability indexes obtained from 8 different positions were calculated for stability index. The stability index indicates the degree of postural sway in 8 different positions, so it can test the overall stability and ability to control and compensate for changes in posture. The higher index score shows a more unstable posture. Normal percentage of weight put on each of the 4 force plates is 25%. A high percentage reflects the pathology on where the weight distribution has changed (13-14).

Statistics

SPSS version 13.0 was used for the statistical analysis. The balance control abilities obtained from posturography of the M and MV and the control groups were analyzed. Student's t test was used to compare the numeric data between groups. Anova test was performed to compare numeric values within each of the 8 testing positions in the 3 groups and the Bonferroni method was used as a post-hoc test for multiple comparisons. Kruskal–Wallis test was used to compare nonparametric values in the 3 groups and Mann-Whitney u test was used to analyze the specific sample pairs for significant differences. If the *P*-value was < 0.05, the result was considered to be statistically significant.

Results

Mean risk of falling values were 43.13 in the M group, 36.13 in the MV group, and 26.88 in the C group and the differences were not statistically significant. Patients are graded according to following groups: low (0 – 35), moderate (36 – 57), and high (58 – 100) risk of falling and Table 2 shows the numbers and percentages of patients according to grade of risk of falling. Ratios of the patients with moderate and high risk of falling were not significantly higher in the M and MV groups compared to the C group.

Analyses of the Fourier index between groups showed the distribution of patients with posturographical abnormalities in the MV group was significantly different than in the C group in low frequencies (F2-4) when the patients were examined in the position with a blue foam rubber pillow on the floor of the machine with open eyes (*P*-value = 0.036). Distributions of the patients according to standard deviations of the Fourier index in the normal-eyes open, normal-eyes closed, pillow-eyes open, and pillow-eyes closed positions are shown in Table 3. In addition distribution of the patients with posturographical abnormalities in the high frequencies (F7-8) of the examination of the head right position was significantly different in the MV group than in the C group (*P*-value = 0.014) and the distribution of the patients with posturographical abnormalities in the high frequencies (F7-8) of the examination of the head left position was significantly different in the

Table 3. ***Distributions of the patients according to standard deviations of Fourier index in the normal-eyes open, normal-eyes closed, pillow-eyes open, and pillow-eyes closed positions.***

Position - Frequency	**SD**	**M (n)**	**MV (n)**	**C (n)**	***P* value**	**Position-Frequency**	**SD**	**M (n)**	**MV (n)**	**C (n)**	***P* value**
normal-eyes open - F1	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	15 1 0 0	15 0 1 0	14 2 0 0	0.790	pillow-eyes open - F1	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	15 1 0 0	14 2 1 0	12 2 0 2	0.276
normal-eyes open - F2-4	1.0-1 – .5 1.5– 3.0 3.0 – 6.0 >6	12 2 2 0	12 2 2 0	13 3 0 0	0.807	pillow-eyes open - F2-4	1.0 – 3.0 1.5 – 3.0 3.0 – 6.0 >6	12 2 2 0	8 6 1 1	15 0 1 0	0.036*
normal-eyes open - F5-6	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	13 3 0 0	12 0 4 0	14 2 0 0	0.506	pillow-eyes open - F5-6	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	15 1 0 0	15 1 0 0	16 0 0 0	0.600
normal-eyes open - F7-8	1.0 – 1.5 1.5 – 3.0 3.0-6.0 >6	12 2 1 1	9 5 2 0	10 3 3 0	0.662	pillow-eyes open - F7-8	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	13 1 2 0	9 6 1 0	14 1 1 0	0.162
normal-eyes closed - F1	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	15 1 0 0	16 0 0 0	14 0 0 2	0.337	pillow-eyes closed - F1	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	16 0 0 0	15 1 0 0	16 0 0 0	0.368
normal-eyes closed - F2-4	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	7 7 2 0	9 5 1 1	13 2 1 0	0.119	pillow-eyes closed -F2-4	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	8 2 5 1	6 5 4 1	13 1 2 0	0.059
normal-eyes closed - F5-6	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	15 1 0 0	12 3 1 0	13 3 0 0	0.339	pillow-eyes closed -F5-6	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	13 2 1 0	14 1 1 0	16 0 0 0	0.220
normal-eyes closed -F7-8	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	13 2 1 0	14 2 0 0	16 0 0 0	0.211	pillow-eyes closed -F7-8	1.0 – 1.5 1.5 – 3.0 3.0 – 6.0 >6	11 3 2 0	12 2 2 0	13 0 3 0	0.842

M: Migraineurs, MV: Migrainous vertigo,C: Controls, SD: Standard Deviations
* $P < 0.05$ between MV and C

M group than in the C group (*P*-value = 0.016). Distributions of the patients and controls according to standard deviations of the Fourier index in the head right, head left, head back, and head forward positions are shown in Table 4.

Comparison of stability and weight distribution indexes in 8 positions in the M, MV, and C groups showed the stability index of the MV group was significantly higher than the C group when tested in the pillow-eyes open position (*P*-value = 0.040). However weight distribution index values were not significantly different between groups. Mean stability index and weight distribution index values of the M, MV, and C groups are shown in Table 5.

Table 4. *Distributions of the patients according to standard deviations of Fourier index in the head right, head left, head back, and head forward positions.*

Position - Frequency	SD	M (n)	MV (n)	C (n)	*P* value	Position - Frequency	SD	M (n)	MV (n)	C (n)	*P* value
head right - F1	1.0 – 1.5	14	15	15	0.737	head back - F1	1.0 – 1.5	14	14	13	0.757
	1.5 – 3.0	1	1	0			1.5 – 3.0	1	1	0	
	3.0 – 6.0	1	0	0			3.0 – 6.0	1	1	0	
	>6	0	0	1			>6	0	0	3	
head right - F2-4	1.0 – 1.5	5	5	9	0.348	head back - F2-4	1.0 – 1.5	7	5	12	0.097
	1.5 – 3.0	6	6	3			1.5 – 3.0	4	7	1	
	3.0 – 6.0	3	3	4			3.0 – 6.0	3	2	3	
	>6	2	2	0			>6	2	2	0	
head right - F5-6	1.0 – 1.5	13	13	12	0.509	head back - F5-6	1.0 – 1.5	14	12	14	0.596
	1.5 – 3.0	2	3	3			1.5 – 3.0	1	4	2	
	3.0 – 6.0	1	0	1			3.0 – 6.0	1	0	0	
	>6	0	0	0			>6	0	0	0	
head right - F7-8	1.0 – 1.5	4	8	12	0.014*	head back - F7-8	1.0 – 1.5	11	11	9	0.696
	1.5 – 3.0	5	4	3			1.5 – 3.0	3	3	4	
	3.0 – 6.0	6	2	1			3.0 – 6.0	2	2	3	
	>6	1	2	0			>6	0	0	0	
head left - F1	1.0 – 1.5	14	15	16	0.316	head forward - F1	1.0 – 1.5	15	13	15	0.418
	1.5 – 3.0	1	1	0			1.5 – 3.0	0	1	0	
	3.0 – 6.0	1	0	0			3.0 – 6.0	1	1	1	
	>6	0	0	0			>6	0	1	0	
head left - F2-4	1.0 – 1.5	7	9	11	0.169	head forward - F2-4	1.0 – 1.5	9	7	12	0.183
	1.5 – 3.0	3	4	4			1.5 – 3.0	2	4	2	
	3.0 – 6.0	4	3	1			3.0 – 6.0	3	3	2	
	>6	2	0	0			>6	2	2	0	
head left - F5-6	1.0 – 1.5	11	12	13	0.667	head forward - F5-6	1.0 – 1.5	15	12	13	0.420
	1.5 – 3.0	2	2	2			1.5 – 3.0	0	4	3	
	3.0 – 6.0	3	2	1			3.0 – 6.0	1	0	0	
	>6	0	0	0			>6	0	0	0	
head left - F7-8	1.0 – 1.5	7	7	14	0.016**	head forward - F7-8	1.0 – 1.5	8	10	13	0.320
	1.5 – 3.0	3	4	1			1.5 – 3.0	6	3	1	
	3.0 – 6.0	3	3	1			3.0 – 6.0	2	2	1	
	>6	3	2	0			>6	0	1	1	

M: Migraineurs; MV: Migrainous vertigo; C: Controls; SD: Standard Deviations; *$P < 0.05$ between MV and C; **$P < 0.05$ between M and C

Discussion

In our study, 16 migraine patients and 16 migrainous vertigo patients were assessed prospectively. When we compared the balance control ability of the M and MV groups to the C group using tetra-ataxiometric posturography, we were able to discover several points of difference. The stability index, which quantitatively measures the postural sway according to changes in the pivoting center, was higher in the pillow-eyes open position of the MV group compared to those of control group. In the pillow-eyes open position the posturographical examination of the patients is being performed on an elastic floor when the patients' eyes are open and heads are on the neutral position. This position eliminates the somato-sensorial system (13). This result is compatible with the study of Harno et al (8) in which static posturography results were attributed to the reliance of the patients on sensory input other than visual. Postural disturbance may be related to the vestibular function, proprioception, spatial–visual orientation, deficits of muscle strength or postural reflexes, orthostatic blood pressure dysfunction, or attention deficits (13,14). So, our results suggest that somato-sensorial system involvement is more related with vestibular symptoms in patients with migraine, because the difference was not significant between M patients and controls. This may be attributed to the effect of a distinct mechanism on vestibular symptoms of migraineurs.

Table 5. *Comparison of weight distribution and stability indexes in 8 positions of M, MV, and control groups.*

Position	Wight Distribution Index					Stability Index				
	M	MV	C	F-value	*P* value	M	MV	C	F-value	*P* value
NO	7.3 ± 4.2	6.6 ± 2.8	7.3 ± 2.9	0.203	0.817	14.6 ± 26	16.8 ± 4.9	14.6 ± 2.5	2.018	0.145
NC	6.4 ± 3.4	6.5 ± 3.9	6.3 ± 2.2	0.018	0.982	20.7 ± 5.7	22.54 ± 6.5	19.3 ± 4.6	1.309	0.280
PO	6.9 ± 4.3	7.8 ± 5.2	10.1±3.7	2.223	0.120	17.1 ± 3.9	19.6 ± 6.3	15.2 ± 3.7	3.458	0.040*
PC	5.3 ± 2.9	7.2 ± 5.0	8.9 ± 3.9	3.298	0.056	28.1 ± 8.6	27.3 ± 6.1	24.8 ± 3.4	1.074	0.350
HR	6.7 ± 3.8	5.4 ± 3.2	7.4 ± 2.4	1.638	0.206	24.1 ± 8.2	22.3 ± 3.8	20.3 ± 5.1	1.580	0.217
HL	6.5 ± 3.6	5.6 ± 3.8	6.1 ± 2.7	0.335	0.717	23.4 ± 7.4	21.7 ± 5.8	20.5 ± 4.0	1.013	0.371
HB	7.4 ± 5.4	5.9 ± 4.0	6.5 ± 2.5	0.976	0.385	25.9 ± 9.5	23.2 ± 4.8	20.2 ± 3.5	2.341	0.108
HF	5.6 ± 3.8	5.4 ± 2.6	5.4 ± 2.4	0.020	0.980	23.7 ± 8.2	21.9 ± 5.0	19.4 ± 4.4	2.007	0.146

M: Migraineurs; MV: Migrainous vertigo; C: Controls; NO: Normal position with eyes open; NC: Normal position with eyes closed; PO: Eyes open on pillows; PC: Eyes closed on pillows; HR: Head turned right and eyes closed; HL: Head turned left and eyes closed; HB: Eyes closed raising head backward 30°; HF: Eyes closed with head forward approximately 30°; *$P < 0.05$ between MV and C

In Fourier index analyses, fluctuation at a low to medium frequency (F2-4) of 0.1 – 0.5 Hz usually signifies an abnormality in the vestibular organ or fatigue of the musculoskeletal system (14,15). In our study, Fourier index showed a larger instability of posture in the MV group than the control group in low frequencies (F2-4) when the patients were examined in the position with a blue foam rubber pillow on the floor of the machine with open eyes. With a conspectus of Fourier index and stability index analyses, this result would be attributed to concomitant involvement of the vestibular and somato-sensorial systems in patients with migrainous vertigo. As vestibular examination alone does not provide enough information for a diagnosis of migrainous vertigo, to perform more detailed examination methods, like posturography, would be very helpful to show the concomitant involvement of the vestibular and somatosensorial systems in patients with migrainous vertigo.

Fluctuation at a high frequency (F7-8) of more than 1 Hz in the Fourier index analyses shows a high index when a postural instability occurs due to a central nervous system abnormality (13,15). We found significant difference of distribution of the patients with posturographical abnormalities in the high frequencies (F7-8) of the head right position between the MV group and C group. In addition, distribution of the patients with posturographical abnormalities in the high frequencies (F7-8) of the examination of the head left position was significantly different in the M group than the C group. The purpose of the head left position is to eliminate the visual system and vestibular stress and the purpose of head back position is to eliminate visual system and the vestibular and cervical stress (15). These positions are sensitive to postural deviations in cases of problems with the vestibular apparatus or the lumbar or cervical vertebrae. These results would be completely attributed to a disturbed central vestibular system in both M and MV patients, because all of the patients in this study had a normal neurological examination that excludes any lumbar or cervical spinal pathology. So, our results suggest that migraine is associated with significant postural instability of central vestibular origin, and the effect of somato-sensorial system involvement is more prominent in the MV group. Although the pathophysiology of vestibular migraine has not been fully understood, our results are consistent with the literature pointing the central vestibular pathology in migraine (16).

There are few posturography studies on patients with migraine or migrainous vertigo (1-6). Increased sway velocity when the eyes were closed or the platform was distorted was reported in patients with migrainous vertigo. The authors attributed the results to peripheral vestibular dysfunction, which was found in 20% of the MV patients than a central deficit (6). The Fourier index analyses of our patients showed the involvement of vestibular apparatus in patients with migraine and migrainous vertigo, but our results suggest dysfunction of the central part of the vestibular system rather than the peripheral part. In addition significant fluctuation that was found at these positions was found at high frequencies, indicating a postural instability due to a central nervous system abnormality. With these results it can be concluded that central part of the vestibular apparatus would be the responsible anatomical structure of postural abnormalities in patients with migraine and migrainous vertigo.

An interesting finding of our study is the existence of posturographical pathologies in both the M and MV group. We thought that this would be explained by an on-going but subclinical effect of migraine on some responsible anatomical structures and posture. In addition we found concomitant involvement of vestibular and somato-sensorial systems in patients with migrainous vertigo. So involvement of multiple systems during the course of the disease would cause a decompensation of postural control in patients with migraine and would cause the symptoms of vestibular pathologies.

The pathophysiology of migrainous vertigo is still unclear and several mechanisms have been proposed for the pathophysiology of migrainous vertigo. The main result of the studies about migrainous vertigo is involvement of both peripheral and central vestibular structures (6,17-19). We think the results of our study are compatible with the literature, and furthermore, our study gives objective results that show the influence of somatosensorial systems on postural stability in patients in migrainous vertigo. But the answer of the question "How the somatosensorial system affects the vestibular system in mignenours?" is not clear. As a possible explanation, Olesen et al (20) support the hypothesis that neuromediator release during the algic phase of migraine produces an increase in the threshold of somatosensorial cues in the central nervous system.

Our study is performed with a small number of patients in a non-randomized design. We were unable to find an answer to the mechanism of involvement of the somatosensorial system and vestibular system in migrainous headaches. Further randomized controlled studies with large numbers of patients are needed to determine a better clinical picture in vestibular migraine patients.

Conclusions

In this first study of tetra-ataxiometric static posturography evaluating postural abnormalities in a well-defined population of patients with migrainous vertigo, tetra-ataxiometric static posturography may be able to identify the central part of the vestibular apparatus as the responsible anatomical structure of postural abnormalities in patients with migraine and migrainous vertigo. We think our findings would be helpful to understand migrainous vertigo but further studies are needed about the pathophysiology of migrainous vertigo and the clinical utility of static posturography in patients with migraine.

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