Body Balance in Patients of Vestibular Migraine with and without Visual Vertigo: A study on Computerized Dynamic Posturography (CDP)

Wessam Mostafa Essawy
Lecturer of Audio-vestibular Unit, Department of Otorhinolaryngology, Faculty of Medicine, Tanta University, Egypt, wessamessawy@yahoo.com

Mai Mohammed El Gohary
Fellow of Audiology, Hearing and speech institute, Egypt

Nashwa Nada
Lecturer of Audio-vestibular Unit, Department of Otorhinolaryngology, Faculty of Medicine, Tanta University, Egypt

Follow this and additional works at: https://www.menoufia-med-j.com/journal

Part of the Medicine and Health Sciences Commons

Recommended Citation
DOI: https://doi.org/10.59204/2314-6788.1027

This Original Study is brought to you for free and open access by Menoufia Medical Journal. It has been accepted for inclusion in Menoufia Medical Journal by an authorized editor of Menoufia Medical Journal. For more information, please contact menoufiamedicaljournal@yahoo.com.
ORIGINAL STUDY

Body Balance in Patients of Vestibular Migraine With and Without Visual Vertigo: A study on Computerized Dynamic Posturography

Wessam M. Essawy a,*, Mai M. El Gohary b, Nashwa Nada a

a Audio-vestibular Unit, Department of Otorhinolaryngology, Faculty of Medicine, Tanta University, Egypt
b Audiology, Hearing and Speech Institute, Egypt

Abstract

Objectives: To evaluate the body balance of vestibular migraine (VM) patients with and without visual vertigo on a computerized dynamic posturography (CDP).

Methods: The subjects included two main groups: a control group of 20 healthy subjects, and the study group included 20 VM subjects with normal caloric test. The study group was further subdivided into two subgroups [vestibular migraine with visual vertigo (VM-VV) and those without visual vertigo (VMØVV)]. Comparisons as regards [stability index (SI), speed, surface area (SA), index of postural instability (IIP), and power indices of various frequency ranges] of the center of pressure at all six conditions were applied between control and vestibular migraineurs subgroups.

Results: One-way ANOVA revealed statistically significant differences between groups ($P < 0.05$). The post hoc test revealed significant differences as regards SA and speed between control healthy and VM-VV in all six conditions, in five of the six conditions as regards IIP and SI, as well as in four of the six conditions as regards power indices of different frequency ranges. Statistically significant differences were found between vestibular migraine subgroups in conditions with a moving atmosphere at some parameters.

Conclusion: Vestibular migraineurs with visual vertigo express significant abnormalities in body balance control. These patients have some sort of reliance on their vision to maintain balance. The presence of visually busy surroundings, like a moving atmosphere, creates an overload on the exhausted vestibular system of such patients. CDP contributes to filling in gaps in the diagnosis of VM, giving insight into the underlying pathology of VM.

Keywords: Computerized dynamic posturography, Migraine, Vestibular migraine, Visual vertigo

1. Background

V estibular migraine (VM) is a clinical condition in which migraine headache and vestibular symptoms are associated, with relevant effects on quality of life [1]. Moreover, many vestibular migraineurs may report imbalance, postural instability, susceptibility to motion sickness, nausea, vomiting, exhaustion, and may also report auditory symptoms [2]. Vestibular symptoms include rotational or non-rotational vertigo, spontaneously or in association with changing positions [3].

The pathophysiology of vestibular migraine is vague. However, the following are the postulated hypotheses: (1) subcortical dysfunction and labyrinth hypersensitivity [4], (2) spontaneous neural activity along the auditory pathway, with abnormal reorganization processes in the level of auditory cortex, central sensitization, cortical hyperexcitability [5,6], cochlear vascularity malfunctioning [7] and (3) migraine-induced vasospasm with subsequent cochlear and labyrinthine ischemia [8], (4) abnormal visual–cortical interaction disruption in the vestibular system was also from the postulated causes [9].
Patients with VM are more vulnerable to visual-induced vertigo (i.e., visual stimuli create an illusion of movement) [10]. Abnormal spatial orientation has been shown in vestibular migraineurs [11]. Those patients become extremely sensitive to visual stimuli, leading to easily triggered vestibular symptoms [11,12].

The Balance Quest-MultiTest is made up of a device with a movable support force plate-form and a visual environment that is disrupted by horizontal optokinetic stimulation (OKS) [13]. Computerized dynamic posturography (CDP) can help to analyze balance disorders in many patients. It gives us more precise quantitative measures of the patient’s sway. These data allow understanding the sensory preferences of the subjects by comparing the results obtained in different conditions [14].

Vestibular migraineurs complain of imbalance and postural instability. Besides, many vestibular migraineurs suffer from visual-induced vertigo and motion thickness [15,16]. Recent studies propose important connections between the trigeminal system and vestibular nuclei that may link visual vertigo, motion sickness, and migraine [17]. Postural tests allow identifying subclinical vestibular dysfunctions that can be clinically significant, even in individuals with no history of dizziness and/or vertigo [18]. Despite this, there have been few clinical trials evaluating postural stability in VM using posturography [10,19,20]. Moreover, there were limited citations in the literature on the limit of stability or changes in sway velocity and pressure center displacement area in vestibular migraineurs with visual vertigo, emphasizing the study’s uniqueness. This study aimed to assess postural stability in VM patients with and without visual vertigo at different conditions on CDP.

2. Methods

This is a case–control observational study done in our Audio-vestibular Unit, in the period from September 2020 to January 2022. The major concept of the research was explained in detail to the participants. Subjects who agreed to participate signed informed consents. Participant may withdraw participation at any time without loss of benefits. The protocol of the study was approved by the ethical committee (35,662).

Subjects in the current study were divided into two groups:

- The healthy group consisted of 20 subjects who reported no history of dizziness, migraine headache, associated comorbidities, or medication use besides no family history of migraine. The study group (VM group) consisted of 20 patients. All patients met the Barany criteria for definite VM [21]. This study group was subdivided into two subgroups (without visual vertigo (VM0VV) and with visual vertigo (VM-VV)). They included twelve and eight patients respectively. Patients were diagnosed as VV when they had at least 3 positive answers for Modified Arabic Version of Mallinson questionnaire (modified visuo-vestibular mismatch (VVM) questionnaire) [22].

Inclusion criteria of the study group were (1) age between 18 and 60 years; (2) diagnosis of vestibular migraine according to the international classification of headache disorder ICHD-3 beta [21]; normal hearing and caloric test results (to avoid that variable in analysis of data and to state any findings in CDP results to vestibular migraine pathology not to the peripheral vestibular pathology).

Exclusion criteria of the study group were (1) presence of another cause of vertigo (such as Meniere’s disease, vestibular neuritis, vertebrobasilar insufficiency, etc.); (2) any other neurological disease; (3) abnormal magnetic resonance imaging (MRI) findings; (4) a history of drug abuse; (5) other primary and secondary headaches; (6) vertigo associated with chronic anxiety without the presence of migraine; (7) head trauma history; and (8) Additionally, participants with any general health issues (such as endocrine, vascular, or renal issues) were also disqualified. Additionally, everyone who had orthopedic issues, severe visual impairment or peripheral neuropathy was disqualified from the trial.

All patients were not at any prophylactic anti-migraine therapy during the exam i.e., they haven’t started the therapy yet. Patients were examined in periods free of headache or vertigo (was done at least one week from the last attack of vestibular migraine).

A detailed history was obtained from each patient via a flexibly structured interview (full neuro-otological history, especially symptoms of vestibular or balance dysfunction, headache, and aura symptoms. A detailed history of migraine attacks, family history of migraine, and previous migraine was also obtained).

All subjects in the current study were submitted to: Arabic version of DHI questionnaire to determine severity of attacks, Pure Tone Audiometry (Madsen Astera (Type-1 audiometry), Video-nystagmography (VNG) using (ICS Chart 200 VNG/ENG- GN Otometrics A/S, Denmark Version 5) and Computerized posturography using (Framiral) equipment version 6.

Balance test was done used Framiral equipment. The subjects were barefoot and were instructed to keep their toes and heels on the sign indicated on
parameters were calculated in the three groups: optokinetic following sequences (eyes open, eyes closed, moving optokinetic field). The first three conditions (A, B, and C) were done with a supporting plate-form. The other three conditions (D, E, and F) were the same but with an unsupported force plate to eliminate the proprioceptive input.

The balance was tested using the classical checkup test, each trial had a fixed 30 s duration. The 1st 10 s were as training and the recording was applied to the other 20 s. Posturography measures changes in the vertical force exerted by the heels and tips of the toes, allowing body sway to be calculated based on the displacement of the individual’s center of pressure (COP) [23].

For each condition from (A to F), the following parameters were calculated in the three groups:

1. Stability Index (SI): The SI gives an idea about the overall stability and ability to compensate postural changes. The percentage of stability for each condition is computed. Zero percentage indicates sway exceeding the limit of stability (i.e., fall) while 100% indicates perfect stability.
2. The surface area (SA) of displacement of the COP (cm²): It is the total area of displacement. The smaller the surface area, the more stable the subject is and vice versa.
3. Speed of the (COP) sway (cm/s): It is determined by approximation of the sway pattern of an ellipse using the maximum and minimum total displacements to the right, to the left, forward and backward. The mean sway velocity was established by the total distance covered by the COP and divided by the time of 30 s of the test [19].
4. Index of postural instability (IIP): This is an overall score that will give us an early indication of the state of postural stability of the subject. The smaller the value, the more the stability is [24].
5. Power index (PI) in different frequencies (low, mid, and high): The power index (PI) shows the energy that a subject expends throughout the conditions to which he is subjected. The higher the power index, the more the subject has significant postural instability [23]. PI is obtained from the wavelet decomposition of stabilkinesigram (Fig. 1). The power of the frequency content represented by a color mode.

Cold color: white, blue, or green denotes low energy expenditure to balance. Warm color: yellow, orange, or red denotes high energy expenditure to balance [23,24]. Thus, from the observation of this 3D mapping, the energy expenditure of the patient during the chosen sequence (time and frequency) could be analyzed and observed. It could be recognized how much energy the subject had to use to balance himself. The frequencies of postural sway vary within a spectrum between 0.01 and 10 Hz. They are measured through the Fourier Transform. Each frequency range of postural sway corresponds to a specific postural subsystem [25]. Abnormalities at low to medium frequency between 0.1 and 0.5 Hz typically signify an issue with the vestibular organ or musculoskeletal system fatigue. Abnormalities at high frequency greater than 1 Hz may be caused by a CNS issue [26].

2.1. Statistical analysis of the collected data

Results were collected, tabulated and statistically analyzed by Graph-pad prism version (7) Two types of statistical analysis were done: a) Descriptive statistics e.g. was expressed in: Number (No), percentage (%) mean (x) and standard deviation. b) Analytic statistics e.g. A one-way analysis of variances (one-way ANOVA) test was used to compare parameters between groups at each condition (A to F). Ordinal one-way ANOVA was applied for normally distributed data. The Kruskal–Wallis Test was applied for not normally distributed data. As a post hoc, Tukey’s multiple comparison test was applied for ordinal one-way ANOVA, while Dunn’s multiple comparison test was applied for Kruskal–Wallis.

The D’Agostino & Pearson normality test was used to test for normal distribution. A Fisher Exact test was used to compare qualitative data between different groups. A two-sided P value of <0.05 was considered statistically significant.

3. Results

Subjects included in this study were divided into 2 main groups. The control group consisted of 20 healthy subjects; their age ranged from 22 to 55 years with mean age (34.85 ± 9.6). The study group included 20 subjects with VM; their age ranged from 24 to 55 years with mean (38.2 ± 9.6). No statistically significant difference between the 2 groups as regards age. Gender distribution was as the following [in the control group (8 males and 12 females) and in the study (6 males and 14 females)] and no significant difference was detected as regard gender distribution (Fisher exact test p value = 0.7).

The duration of dizziness ranged from 6 to 24 months with a mean of 11 ± 6 months. The rate of attack per month varied from 3 to 15/months and with a mean of 9 ± 5/month. All patients reported
history of migraine headache that occurred earlier in life with age of onset ranged from (8–30) years with mean ± SD (16 ± 6).

As regards the audiological tests, all patients in the control and study groups showed normal hearing threshold level and bilateral type (A) tympanogram indicating normal middle ear function.

On VNG testing, twelve patients showed abnormal oculomotor test findings, by the Dix–Hallpike test six patients showed a positive test for BPPV. The latter were corrected with canal repositioning maneuver before doing the CDP.

Posturography results: comparison between control group and study subgroups (VMØOV & VM-VV) was done for each measured parameter (SR, SA, speed, IIP and low, mid, high-power indices) at each condition from (A to F) using one-way ANOVA.

As regards Condition A (stable foot plate with eye open): apart from the speed and SA there were no statistically significant differences between all groups in all measured parameters. As regards Condition B (Stable platform with closed eyes): Statistically significant differences appeared between groups as regards speed, SI, SA and IIP. From conditions C to F all parameters showed statistically significant differences between groups.

Post hoc multiple comparisons test revealed persistent and constant significant differences in P2 (control versus VM-VV) in SA, SI, IIP, and speed in five of the six conditions, as well as in power indices of different frequency ranges in four of the six conditions. Statistically significant differences were found between VM-VV and VM ØVV in conditions with moving atmosphere (C, F). As regards speed, IIP, SI, Mid and high frequency PI (Tables 1–3).

On the contrarily, VM ØVV showed poorer performance than the control healthy group, however, this does not reach the significant level except for some parameters in different conditions. As regards SI and SA they reached significant differences in

Table 1. Comparison between control healthy and study subgroups [Vestibular migraineurs with and without visual vertigo (VM-VV and VMØVV)] in all conditions as regards Posture Instability Index (IIP).

<table>
<thead>
<tr>
<th>Classical Conditions</th>
<th>Control group (n=20)</th>
<th>VMØOV (n=12)</th>
<th>VM-VV group (n=8)</th>
<th>One-way ANOVA</th>
<th>Post hoc multiple comparison test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition (A)</td>
<td>1 ± 0.7</td>
<td>1.47 ± 1</td>
<td>1.7 ± 0.8</td>
<td>2.8 ns</td>
<td></td>
</tr>
<tr>
<td>Condition (B)</td>
<td>0.89 ± 0.5</td>
<td>1.3 ± 0.9</td>
<td>1.96 ± 0.8</td>
<td>6.3 **</td>
<td>P1 P2** P3</td>
</tr>
<tr>
<td>Condition (C)</td>
<td>0.8 ± 0.48</td>
<td>1.5 ± 0.9</td>
<td>2.6 ± 0.6</td>
<td>20 ****</td>
<td>P1* P2*** P3***</td>
</tr>
<tr>
<td>Condition (D)</td>
<td>2.2 ± 0.7</td>
<td>3.2 ± 0.8</td>
<td>3.9 ± 0.98</td>
<td>14.16 ****</td>
<td>P1** P2**** P3***</td>
</tr>
<tr>
<td>Condition (E)</td>
<td>2.7 ± 1</td>
<td>3.2 ± 1</td>
<td>4.2 ± 1.2</td>
<td>5.6 **</td>
<td>P1 P2** P3</td>
</tr>
<tr>
<td>Condition (F)</td>
<td>2.3 ± 0.8</td>
<td>2.9 ± 0.6</td>
<td>4.6 ± 1.2</td>
<td>24.4 ****</td>
<td>P1 P2*** P3***</td>
</tr>
</tbody>
</table>

Vestibular migraineurs without visual vertigo (VMØOV), Vestibular migraineurs with visual vertigo (VM-VV).

Ordinal one-way ANOVA with (F value) was applied for normally distributed data.

Kruskal Wallis Test with (Kruskal Wallis value) was applied for not normally distributed data.

P1 = control versus VMØOV.

P2 = control versus VM-VV.

P3 = VMØOV versus VM-VV.

P value significant when <0.05, [* = P ≤ 0.05; ** = P ≤ 0.01; *** = P ≤ 0.001; **** = P ≤ 0.0001].

Table 2. Comparison between control healthy and study subgroups [Vestibular migraineurs with and without visual vertigo (VM-VV and VMØOV)] in all conditions as regards Speed (cm/s).

<table>
<thead>
<tr>
<th>Classical Conditions</th>
<th>Control group (n=20)</th>
<th>VMØOV (n=12)</th>
<th>VM-VV group (n=8)</th>
<th>Kruskal Wallis Statistics</th>
<th>P value</th>
<th>Post Hoc test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition (A)</td>
<td>6 ± 2.6</td>
<td>9 ± 7.28</td>
<td>11.13 ± 3.6</td>
<td>8.491 *</td>
<td>P1 P2* P3</td>
<td></td>
</tr>
<tr>
<td>Condition (B)</td>
<td>6.7 ± 2.2</td>
<td>8 ± 4.8</td>
<td>14.75 ± 5.12</td>
<td>12.23 **</td>
<td>P1 P2** P3</td>
<td></td>
</tr>
<tr>
<td>Condition (C)</td>
<td>6 ± 1.2</td>
<td>8.5 ± 5.3</td>
<td>17.6 ± 4</td>
<td>17.2 **</td>
<td>P1 P2** P3**</td>
<td></td>
</tr>
<tr>
<td>Condition (D)</td>
<td>14.7 ± 6</td>
<td>28.9 ± 17.8</td>
<td>35.6 ± 18</td>
<td>9.374 **</td>
<td>P1 P2* P3</td>
<td></td>
</tr>
<tr>
<td>Condition (E)</td>
<td>20.7 ± 14.7</td>
<td>27.6 ± 19.5</td>
<td>49.8 ± 34.8</td>
<td>6.886 *</td>
<td>P1 P2* P3</td>
<td></td>
</tr>
<tr>
<td>Condition (F)</td>
<td>14.6 ± 7.8</td>
<td>19 ± 12.5</td>
<td>58.5 ± 24.19</td>
<td>18.49 ****</td>
<td>P1 P2*** P3****</td>
<td></td>
</tr>
</tbody>
</table>

Vestibular migraineurs without visual vertigo (VMØOV), Vestibular migraineurs with visual vertigo (VM-VV).

Ordinal one-way ANOVA with (F value) was applied for normally distributed data.

Kruskal Wallis Test with (Kruskal Wallis value) was applied for not normally distributed data.

P1 = control versus VMØOV.

P2 = control versus VM-VV.

P3 = VMØOV versus VM-VV.

P value significant when <0.05, [* = P ≤ 0.05; ** = P ≤ 0.01; *** = P ≤ 0.001; **** = P ≤ 0.0001].
four out of six conditions. As regards IIP and power indices of low to mid frequency the significant differences were found in two out of six conditions. As regards high-frequency PI, it was only in one condition. While as regards speed, no significant differences were found between VMØVV and healthy controls. Figures 1–3.

4. Discussion

Vestibular migraine (VM) is a challenging disorder. It is considered one of the most frequent vertiginous cases in everyday clinics.

The CDP measures postural sway caused by exposure to various situations on stable or firm surfaces with eyes open, eyes closed, and with visual stimulation. It assesses the interplay between the visual, somatosensory, and vestibular systems [19]. Here, we attempted to assess how VM patients with normal caloric tests and with visual vertigo would react when subjected to various challenging conditions using this test.

In the current study, statistically significant differences in all measured parameters were detected in patients with VM-VV than VMØVV and both had lower results than healthy peers. Post hoc
multiple comparisons revealed that the main and significant differences in all parameters were found between the control and VM-VV groups. All scores were significantly affected in the VM-VV group. Statistically significant differences were found between both study subgroups at conditions of OKS, indicating less effective central adaptive mechanisms for suppression of the conflicting visual input [10].

Vestibular migraineurs have some sort of reliance on their vision to maintain their balance. The presence of external optical noise circumstances, like OKS, creates an overload on the exhausted vestibular system. The effect of visual busy stimuli on the vestibular system is analogous to the noise effect on speech discrimination in the auditory system. OKS acts like the noise of the vestibular system that forces bodies to express mid and high-frequency energy oscillation together with increasing the body speed to keep the body balance. This was reported previously in a study conducted by Cousins et al. They found that visual vertigo impairs the task of detecting the direction of self-motion [28]. Guerraz et al., 2001 studied body sway in four conditions: eyes closed, eyes open, facing the tilted frame and during disc rotation. They found that VV patients had abnormally large perceptual and postural responses to disorienting visual environments. The findings suggested that VV developed in vestibular patients if they had greater visual reliance and trouble resolving conflicts between visual and vestibulo-proprioceptive signals. It should be advantageous to administer visual motion desensitization to these patients, such as repeated OKS [29,30].

According to research by [31], the instability caused by OKS in the VM group happened in the direction of OKS. This research looked at how OKS affected vestibular postural control in migraine patients with recurrent vertigo. They proposed that, in the absence of further vestibular symptoms, the instability shown following OKS may be regarded a helpful finding to support the diagnostic criteria for VM. 31. Lim et al. [10], also reported that patients with VM were more affected by visual stimuli and exhibited more movements while trying to keep a static stance. Also, Rossi et al. [32], found increased postural sway but only during OKS and only in the migraineurs. Bednarczuk et al. [9] found elevated reflexive and perceptual vestibular thresholds in VM patients at baseline. These thresholds showed further increase following visual motion exposure, relative to healthy controls. They noted that visual vertigo affects the ability to discern the direction of one's own motion. They proposed that, visual vertigo acts like tinnitus of the vestibular system ‘tinnitus of the dizzy patients’, impacting upon the task of detecting the direction of self-motion [9]. These findings might be of central origin and due to abnormal visual-vestibular cortical interactions in VM.

In normal subjects, the energy expenditure in low frequencies is larger compared to the mid and high frequencies. Energy expenditure in healthy subjects is done on a recruitment basis with priority for the

Vestibular migraineurs have some sort of reliance on their vision to maintain their balance. The presence of external optical noise circumstances, like OKS, creates an overload on the exhausted vestibular system. The effect of visual busy stimuli on the vestibular system is analogous to the noise effect on speech discrimination in the auditory system. OKS acts like the noise of the vestibular system that forces bodies to express mid and high-frequency energy oscillation together with increasing the body speed to keep the body balance. This was reported previously in a study conducted by Cousins et al. They found that visual vertigo impairs the task of detecting the direction of self-motion [28]. Guerraz et al., 2001 studied body sway in four conditions: eyes closed, eyes open, facing the tilted frame and during disc rotation. They found that VV patients had abnormally large perceptual and postural responses to disorienting visual environments. The findings suggested that VV developed in vestibular patients if they had greater visual reliance and trouble resolving conflicts between visual and vestibulo-proprioceptive signals. It should be advantageous to administer visual motion desensitization to these patients, such as repeated OKS [29,30].

According to research by [31], the instability caused by OKS in the VM group happened in the direction of OKS. This research looked at how OKS affected vestibular postural control in migraine patients with recurrent vertigo. They proposed that, in the absence of further vestibular symptoms, the instability shown following OKS may be regarded a helpful finding to support the diagnostic criteria for VM. 31. Lim et al. [10], also reported that patients with VM were more affected by visual stimuli and exhibited more movements while trying to keep a static stance. Also, Rossi et al. [32], found increased postural sway but only during OKS and only in the migraineurs. Bednarczuk et al. [9] found elevated reflexive and perceptual vestibular thresholds in VM patients at baseline. These thresholds showed further increase following visual motion exposure, relative to healthy controls. They noted that visual vertigo affects the ability to discern the direction of one's own motion. They proposed that, visual vertigo acts like tinnitus of the vestibular system ‘tinnitus of the dizzy patients’, impacting upon the task of detecting the direction of self-motion [9]. These findings might be of central origin and due to abnormal visual-vestibular cortical interactions in VM.

In normal subjects, the energy expenditure in low frequencies is larger compared to the mid and high frequencies. Energy expenditure in healthy subjects is done on a recruitment basis with priority for the
low frequencies. The more severe the instability, the more the recruitment for the mid to high frequencies will occur [32]. Thus, in VM patients especially those with VV, these values dramatically increase especially in unstable conditions. Hence, the difference in values between the healthy and VM-VV subjects became statistically significant. Each frequency range of postural sway refers to a certain postural subsystem [25]. Abnormalities at a low to medium frequency from 0.1 to 0.5 Hz usually denote an abnormality in the vestibular organ or fatigue of the musculoskeletal system [26]. Abnormalities at a high frequency of more than 1 Hz may be due to a CNS abnormality [26]. As there were statistically significant differences in all three frequency ranges spectrum, hence, it was postulated that the underlying pathology affected the ‘VSR’ and also the central nervous system’. This was also documented in a study done by [20,25].

Gorski et al., reported that the significant sway in low-medium frequencies was higher in the study group in three conditions, and the significant sway in medium—high frequencies in two conditions. They explained those changes in these conditions due to the central nervous system and vestibulocervical disorders. However, both studies included VM without declaration whether they have VV or not. So, presence of visuospatial error in VM patients are related to altered sensory processing and integration that contributes to the perception of spatial orientation [33]. Presence of such complaint suggest involvement of higher-order neural mechanisms within these cortical regions that are responsible for sensory integration for coherent spatial perception [34].

4.1. Limitation

The small sample size is a limitation of the present study. Future studies with a larger sample size are recommended.

4.2. Conclusions

Vestibular migraineurs with visual vertigo demonstrated substantial imbalance control problems. VM-VV have some form of reliance on their vision to help them stay balanced. The presence of visually stimulating surroundings, such as a moving atmosphere, overwhelms these patients’ worn-out vestibular systems. CDP aids in completing any gaps in the VM diagnosis. Identification of body balance impairment characteristics in patients with vestibular migraine may have important diagnostic, preventive, and therapeutic implications especially in the design of customized vestibular rehabilitation programs.

Funding

None (This research didn’t receive any specific grant from funding agencies in the public, commercial or not for profit sectors).

Ethical approval

Ethical approval Code No. 33092/01/19.

Consent for publication

All authors approve publication.

Availability of data and material

Data is available (if needed) for revision.

Conflicts of interest

There are no conflicts of interest.

References


