Research Article

Vestibular Autorotation Test (VAT) in vestibular migraine patients

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Abstract

Objective: To investigate the high-frequency vestibulo-ocular reflex (VOR) in patients with Vestibular migraine (VM). **Background:** VM is a common cause of dizziness. Although many vestibular testing abnormalities have been documented in VM patients, high-frequency VOR abnormalities have not been reported. **Methods**: Sixty five subjects were studied with the vestibular autorotation test (VAT®), involving a control group and study group; the control group consisted of (١٥) subjects, the study group consisted of (٥٠) subjects with VM according to the diagnostic of c criteria ICHD-٣, ٢٠١٣. **Results:** The most frequent VAT abnormality was in the vertical gain (٥٦ %), followed by the horizontal gain (٥٤ %) and finally the VAT asymmetry (١٠ %).Results showed that the VM group had statistically lower horizontal gain in frequencies higher than ٤.٧ Hz. Moreover, VM group had lower vertical gain in the frequencies from ٢ Hz to ٣.٩ Hz. On the other hand, no statistical significant difference between the two groups as regards the horizontal and vertical phase. **Conclusions:** The results suggest that patients with VM may have an abnormal vertical VOR at higher head movement frequencies.

Kry words: Vestibular Autorotation**,** migraine patients, vestibulo-ocular

Introduction

Vestibular migraine (VM) is largely accepted in the vestibular community and represents the second most common cause of vertigo after benign positional vertigo and the most common cause of spontaneous episodic vertigo**,** by far exceeding Menière's disease (Neuhauser et al., .٢٠٠٦; Lempert and Neuhauser, ٢٠٠٩).

VM is diagnosed on the basis of the history and clinical information. The international Classification of Headache Disorder (ICHD-٣, ٢٠١٣) proposed diagnostic criteria for VM**.** These diagnostic criteria are: (١) at least five episodes of moderate or severe intensity vestibular symptoms, (٢) current or past history of migraine without aura or migraine with aura, (٣) at least ٥٠٪ of the episodes are associated with at least one of the three migrainous features: (a) headache with at least two of the following four characteristics: unilateral location, pulsating quality, moderate or severe intensity or aggravation by routine physical activity, (b) photophobia and/or phonophobia and (c) visual aura (٤) and the symptoms are not accounted by another vestibular disorder or another diagnosis listed in the international classification of headache disorder, ٣rd version.

VOR abnormalities have been based on low frequency range (below than ١Hz) as caloric and rotary chair testing. Both tests evaluate the VOR in non-physiologic range of frequencies. Testing the VOR at higher and more physiologic range of frequencies may be more sensitive in the diagnosis of VOR abnormalities in VM patients. VAT evaluates the VOR at high frequencies (٢-٦ Hz). In addition, it evaluates the VOR in the horizontal and vertical planes, which is another advantage over the caloric and rotary

chair testing. Abnormalities of these VOR parameters, however, have never been documented in VM patients. Here, we present a group of VM patients studied with the vestibular autorotation test (VAT®), a test of the high-frequency horizontal and vertical VOR.

Materials and methods

This was a prospective study involving a control group and study group; the control group consisted of (١٥) subjects were chosen to be age and sex matched with those in the study group. Age range between (٢٢) and (٤٤) years old. They were three males and ١٢ females. The study group consisted of (٥٠) subjects with VM according to the diagnostic criteria. Group of VM patients had mean age of (٣٥.٢) and age range between (٢٣) and (٥٥) years old. They were nine males and ٤١ females. According to ICHD-٣, ٢٠١٣,

Subjects participated in the current study were examined after taking an oral consent following detailed explanation of the study procedure. The study was approved by the research ethical committee in Minia University.

All patients were tested with the VAT® (Western Systems Research, Inc., Pasadena, CA). The VAT® is a computerized device, which consists of a headband with a built-in accelerometer for measuring head movement as well as electrodes for measuring eye movements. Five electrodes are placed around the eyes: two vertical electrodes, two horizontal electrodes, and one reference electrode. During testing, the patient fixates on a wall target in a dimly lighted room. A tone is generated by the computer and the subject moves his or her head at the same frequency as the tone. The tone begins at a low frequency, and then becomes progressively faster. The eye and head movements are recorded simultaneously by the computer. Three trials each for horizontal and vertical testing are completed. The software calculates two values for vertical and horizontal head-eye movements: gain and phase. The gain is the amplitude of head movement compared to the amplitude eye movement. The phase is the timing of head movement compared to eye movement.

Results

Frequency ranges from ٢ Hz to ٥.٩ Hz were evaluated. The data obtained from the VM patients were compared to the normative data from the control group using the independent sample median test. The most frequent VAT abnormality was in the vertical gain (٥٦ %), followed by the horizontal gain (٥٤ %) and finally the VAT asymmetry (١٠ %).

Table ١: Percentage of VAT abnormalities in VM group.

	H. Gain	V. Gain	H. Phase	V. Phase	Asymmetry
% of abnormality	٢٧/٥٠ (٥٤٪)	٢٨/٥٠ (٥٦٪)	Zero %	Zero%	٥/٥٠ (١٠ %)

H= horizontal V= vertical

Table (٢-٥) show minimum, maximum, mean, SD, P value and median of both the horizontal and vertical gain, horizontal and vertical phase of the control group and VM group. The tables also show the independent sample median tests to compare between the two groups as regards the gain and phase. Results showed that the VM group had statistically lower horizontal gain in frequencies higher than ٤.٧ Hz. Moreover, VM group had lower vertical gain in the frequencies from ٢ Hz to ٣.٩ Hz. On the other hand, no statistical significant difference between the two groups as regards the horizontal and vertical phase.

Table ٢: Comparison between the control group and VM group, in addition to the independent sample median test as regards horizontal gain.

Horizontal gain in Hz		٢Hz	٢.٣	٢.٧	٣.١	٣.٥	٣.٩	٤.٣	٤.٧	٥.١	٥.٥	٥.٩
Mean	Control group	٠.٩٩	٠.٩٩	٠.٩٧	٠.٩٤	٠.٩٨	٠.٩٢	٠.٨٩	٠.٨٥	٠.٨٨	٠.٨٧	٠.٨٦
	VM group	٠.٨٩	٠.٨٨	٠.٨٨	٠.٨٧	٠.٨٤	٠.٨٦	٠.٨٤	٠.٨٣	٠.٧٦	٠.٧٢	٠.٧٣
Min	Control group	٠.٨٣	٠.٨١	٠.٨	٠.٧٨	٠.٧٦	٠.٧٤	٠.٦٦	٠.٦١	٠.٧٥	٠.٧٩	٠.٧٦
	VM group	٠.٦٥	٠.٦٦	٠.٧	٠.٦٣	٠.٦٣	٠.٥٩	٠.٥٤	٠.٦٣	٠.٥٤	٠.٥١	٠.٥٣
Max	Control group	١.١٤	١.١٧	١.١	١.١	١.١٧	١.١	١.٠٧	٠.٩٥	٠.٩٦	١.٠١	١.٠٥
	VM group	١.٠٦	١	١.٠٢	١.٠١	١	١.٠٩	١.٠٦	١.٠٦	١.٠٦	١.٠٣	١.٠٢
SD	Control group	٠.١٠	٠.١٢	٠.١١	٠.١٢	٠.١٥	٠.١٢	٠.١٣	٠.١٢	٠.٠٨	٠.٠٧	٠.١٠
	VM group	٠.٠٩	٠.٠٩	٠.١٠	٠.١١	٠.١٣	٠.١٦	٠.١٦	٠.١٣	٠.١٥	٠.١٦	٠.١٦
Median	Control group	٠.٩٦	٠.٩٦	٠.٩٥	٠.٩١	٠.٩٦	٠.٩١	٠.٨٩	٠.٩	٠.٨٨	٠.٨٥	٠.٨٦
	VM group	٠.٨٨	٠.٩١	٠.٩	٠.٨٨	٠.٨٧	٠.٨٦٥	٠.٨١٥	٠.٨٢٥	٠.٧٦	٠.٧	٠.٦٦
P value	٠.٣١١	٠.٣١١	٠.٦٣٥	.٩٩	٠.٦١٧	٠.٦٢٨	٠.٦٢٨	٠.٥٩٣	٠.٢٨٢	٠.٠٣	٠.٠.٠٣	٠.٠٢

Table (٣): Comparison between the control group and VM group, in addition to the independent sample median test as regards vertical gain.

vertical gain in Hz		٢Hz	٢.٣	٢.٧	٣.١	٣.٥	٣.٩	٤.٣	٤.٧	٥.١	٥.٥	٥.٩
Mean	Control group	٠.٩٥	٠.٩٧	٠.٩٧	٠.٩٦	٠.٩٦	٠.٩٨	٠.٩٨	٠.٩٨	٠.٩٥	٠.٩١	١.٠١
	VM group	٠.٨	٠.٨	٠.٨	٠.٨	٠.٨	٠.٨	٠.٨	٠.٨	٠.٩	٠.٩	١.٠
Min	Control group	٠.٩	٠.٨٨	٠.٨٤	٠.٨١	٠.٧٦	٠.٧٣	٠.٧٢	٠.٧٣	٠.٧٦	٠.٨٢	٠.٩١
	VM group	٠.٥٥	٠.٥٩	٠.٦	٠.٦	٠.٥٩	٠.٦٤	٠.٥٩	٠.٥٢	٠.٧	٠.٨٦	٠.٨٤
Max	Control group	٠.٩٧	١.٠١	١.٠٣	١.٠٦	١.٠٦	١.١٢	١.٠٧	١.٠٩	١.١٢	٠.٩٥	١.١١
	VM group	١.٠٥	١.١	١.٠٢	١.٠٨	١.١٧	٠.٩٩	٠.٩٦	٠.٩٦	١.٠٧	١.٠٢	١.٠٢
SD	Control group	٠.٠٣	٠.٠٥	٠.٠٧	٠.٠٨	٠.١٠	٠.١٣	٠.١٣	٠.١٤	٠.١٢	٠.٠٦	٠.١٠
	VM group	٠.١	٠.٢	٠.٢	٠.٢	٠.٢	٠.١	٠.١	٠.١	٠.١	٠.١	٠.١
Median	Control group	٠.٩٦	٠.٩٩	٠.٩٨	٠.٩٧	٠.٩٨	٠.٩٩	١.٠٦	١.٠٧	٠.٩٨	٠.٩٥	١.٠٠٥
	VM group	٠.٧٩٥	٠.٧٦	٠.٧٦	٠.٧٣٥	٠.٧٢٥	٠.٧٦	٠.٨٥	٠.٨٣	٠.٨٦٥	٠.٩٢	١
P value		٠.٠٣	٠.٠٢	٠.٠٢	٠.٠٢	٠.٠٢	٠.٠٢	٠.٠٨	٠.٢٤٢	٠.٠٨	٠.٤٢٩	٠.٩٩

Table (٤): Comparison between the control group and VM group, in addition to the independent sample median test as regards horizontal phase.

Horizontal phase in Hz		٢Hz	٢.٣	٢.٧	٣.١	٣.٥	٣.٩	٤.٣	٤.٧	٥.١	٥.٥	٥.٩
Mean	Control group	١٨٥.٧	١٨٦.٠	١٨٦.١	١٨٦.٠	١٤٩.٩	١٨٦.٢	١٨٥.٤	١٨٠.٤	١٨١.٦	١٩١.٦	١٩٠.٠
	VM group	١٨٧.٧٩	٨٩.٦٩	١٩٣.٦٨	١٩٦.٠٤	١٩٦.٠٥	١٩٦.٦٦	١٩٧.١٧	١٩٨.٠٢	١٩٩.١١	٢٠٠.٨٤	١٩٨.٣١
Min	Control group	١٨٤.٧	١٨٤.٣	١٨٣.٧	١٨٣.٣	٣.٨	١٧٥.٩	١٧٢.٤	١٦٦.٨	١٥٥.٧	١٨٠.٤	١٨٠.٤
	VM group	١٦١	١٧٢.٥	١٧٥.٤	١٧٢.٤	١٧٠.٢	١٦٩.٦	١٦٥.٧	١٦٩.٣	١٦٣.٨	١٦٠.٨	١٥٤.٣
Max	Control group	١٨٥.٨	١٨٦.٠	١٨٦.١	١٨٦.٠	١٨١.٥	١٨٦.٢	١٨٥.٤	١٨٠.٤	١٨١.٦	١٩٩.٠	١٩٠.٠
	VM group	٢٠٣.٦	٢٠٩.٥	٢١٦.٩	٢٢٥.١	٢٣٤.٤	٢٤٤.٧	٢٥٥.٥	٢٨٥.٨	٢٩٧.٣	٣٠٦.٢	٣١٢.٩
SD	Control group	٠.٦	١.٠	١.٦	٢.٢	٧٣.١	٥.٥	٧.٥	٨.٤	١٤.٧	٧.٦	٨.٠
	VM group	٩.٠٤	٩.٠٧	١١.٣٠	١٣.٩٢	١٥.١٩	١٩.٥٤	٢٣.٢٤	٣١.٤٨	٣٦.٠٥	٣٧.٥٨	٤٥.٥٠
Median	Control group	١٨٥.٨	١٨٥.٧	١٨٤.٧	١٨٣.٦	١٨١.٥	١٧٥.٩	١٧٢.٤	١٦٦.٨	١٥٥.٧	١٩٩	١٨٦
	VM group	١٨٧.٩	١٨٧.٥	١٩٠.٤٥	١٨٩.٩	١٩٢.١	١٩١.٦	١٨٩.٥٥	١٨٩.٣٥	١٩١.١	١٩٣.٧	١٨٢.٤
P value		٠.٣١١	٠.٠٤٠	٠.٠٣٥	٠.٠٣٣	٠.٣٠٣	٠.٣٠٣	٠.٩٩	٠.٢٩٤	٠.٩٩	٠.٩٩	٠.٥٩٢

Table (٥): Comparison between the control group and VM group, in addition to the independent sample median test as regards vertical phase.

vertical phase in Hz		٢Hz	٢.٣	٢.٧	٣.١	٣.٥	٣.٩	٤.٣	٤.٧	٥.١	٥.٥	٥.٩
Mean	Control group	١٨٥	١٨٦.٢	١٨٧.٤	١٨٨.٨٤	١٩١.١٤	١٩٢.٧٤	١٩٥.٩٨	١٩٨.٨٦	٢٠٠.٤٧٥	٢٠٣.٢٢٥	٢٠٣.٧
	VM group	١٨٣.٣٠	١٨٤.٨٨	١٨١.٧٠	١٨٠.٦٥	١٨٦.٢١	١٨٩.٧٩	١٨٨.٩٠	١٩٢.٩٤	١٨٩.٩٥	١٩٩.٢٦	٢٠٠.٣٢
Min	Control group	١٧٨.٨	١٨٠	١٨١.٥	١٨٣.٢	١٨٥.٢	١٨٧.٣	١٨٩.٥	١٩٢.٥	١٩٦.١	١٩٨.٩	١٩٢.٣
	VM group	١٦٣	١٧٣.٣	١٦٩	١٥٧	١٦٧.٢	١٦٦.٦	١٦٣.٦	١٥٩	١٥٩.٦	١٩٣.٣	٢٠٠
Max	Control group	١٩٣.٢	١٩٤.٧	١٩٥.٥	١٩٦.٨	٢٠٠.٧	٢٠١.٧	٢٠٢.٧	٢٠٤.٨	٢٠٩.٨	٢١٤.٦	٢١٧.٩
	VM group	١٩١.٣	١٩٠.٨	١٩٢.٤	١٩١.٥	٢٠٠	٢٠٩.٣	٢٠٣.٤	٢٠٩.٦	٢١٥.٩	٢٢١.١	٢٠٠.٤
SD	Control group	٤.٧٠	٤.٩١	٤.٦٨	٤.٤٨	٥.١٢	٤.٨٧	٤.٣٢	٤.٧٠	٥.٤٤	٦.٥٨	٩.١٦
	VM group	٦.٣٢	٤.٢٤	٥.٢٢	٨.٣٠	٨.٠٢	١٠.٤٣	١٠.٦٨	١٣.٦٠	١٤.٨٠	٩.١٢	٠.١٦
Median	Control group	١٨٥.١	١٨٦.٦	١٨٧.٨	١٨٨.٨	١٩٠	١٩٠.٧	١٩٤.٩	١٩٦.٦	١٩٨	١٩٩.٧	
	VM group	١٨٣.٥٥	١٨٥	١٨٢.٦	١٨٠.٦	١٨٨	١٨٩	١٨٩	١٩٦	١٨٧.١	١٩٥.١	٢٠٠.٤
P value		٠.٦٢٨	٠.٦٠٣	٠.١١١	٠.١٣١	٠.٠٨٩	٠.٢٦٦	٠.١٠٣	٠.٠٥٩	٠.٥٤٥	٠.٢٤٢	

Discussion

The VAT® test provides five categories of information (i) horizontal gain, (ii) horizontal phase, (iii) asymmetry, (iv) vertical gain, and (v) vertical phase. Our data demonstrate that the VAT® abnormality associated is that the VM group had statistically lower horizontal gain in frequencies higher than ٤.٧ Hz. Moreover, VM group h ad lower vertical gain in the frequencies from ٢ Hz to ٣.٩ Hz. On the other hand, no statistical significant difference between the two groups as regards the horizontal and vertical phase. VM has been associated with both benign positional vertigo (BPPV) (Ishiyama et al., ٢٠٠٠) and Ménière's disease (Radtke et al., ٢٠٠٢) Curiously, both BPPV and Ménière's disease also have been associated with vertical abnormalities on VAT® (O'Leary and Davis, ١٩٩٠; Belafsky et al., ٢٠٠٠) In these studies, BPPV was associated with abnormal vertical phases and Ménière's was associated with abnormal vertical gains. Given the fact that VM clearly is associated with the early onset of motion sickness (Barabas et al., ١٩٨٣) we can speculate that perhaps a common link to vestibular symptoms and migraine may be an abnormality of the vertical VOR. To appreciate the influence of the vertical VOR on visual stability.

Conclusions

One dilemma in studying the vertical VOR, particularly at higher frequencies, is the fact that only two types of tests are available for evaluating this reflex: autorotation testing, of which the VAT® test is an example, and dynamic visual acuity (DVA). DVA is a functional test of changes in visual acuity that occur during head movement. Although DVA provides valuable subjective information about visual blurring, only autorotational testing provides objective physiological data. We feel that further studies of the VOR with both autorotational and DVA may lead to a better understanding VM, particularly those associated with head movement.

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