Visual vestibular mismatch: is it a vestibular disorder?

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Background
Visual vestibular mismatch (VVM) is a group of symptoms rather than a disease. All are exaggerated by introducing any visual conflict. For such reason, there is no adequate tools to investigate or to diagnose and limited research studies were done to explore such group of people.
Aim
To identify VVM disorder among dizzy patients and to study the vestibular function in them.
Patients and methods
This study was conducted on 30 patients suffering from VVM (out of 153 patients) who were selected by a questionnaire modified by the authors based on the original questionnaire. All patients were subjected to objective testing including: full neuro-otological history, office vestibular tests including dynamic visual test (DVA), modified clinical test of sensory integration of balance (MCTSIB), Fukuda stepping test, functional reach test, videonystagmography and vestibular evoked myogenic potentials (VEMPs).
Results
VVM symptomatology was found in 19 patients (subjectively by Mallison questionnaire) and reached 30 patients using a modified questionnaire. 23.33% patients had abnormal Fukuda test, 26.6% had abnormal functional reach test, while 97.6% of patients had abnormal MCTSIB test scores and 50% had abnormal DVA test scores. Abnormal cervical VEMP test results were present in 50% of cases, while only 10% suffered from videonystagmography abnormalities reflecting minor affection of semicircular canals as compared with the saccule.
Conclusion
This study showed that VVM is a fairly common complain among the dizzy population and it can be easily picked up using a simple questionnaire. Office tests as DVA and MCTSIB were highly sensitive tests for VVM patients but more research is needed to find the correlations between these tests and VVM. The study pointed out to the importance of cervical VEMP test to be routinely enrolled in testing of patients with suggestive symptoms of VVM. Further researches should be conducted for knowing the underlying cause and the exact role of saccule in VVM.

Keywords:
cervical vestibular evoked myogenic potential, modified clinical test of sensory integration of balance, visual vestibular mismatch, visual vestibular mismatch questionnaire

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Introduction

The term 'visual vestibular mismatch' (VVM) was first used by Benson and King [1,2]. They used this term to describe a 'motion cue mismatch'. They suggested it as a part of the system complex known as neural mismatch. Present studies have demonstrated that VVM is a symptom set that arises as a result of pathology within the balance system, to the point where it can no longer act as the 'template' against which other sensory information is compared. The result is an inappropriate reliance on environmental visual cues, even under circumstances in which they are orientationally inaccurate [1].

Visual vertigo is the most common symptom of VVM, which is an inappropriate response to motion of the visual environment due to overreliance or misinterpretation of visual cues (visual dependence) [3,4]. Usually dizziness is triggered or increased in the surroundings with profuse visual motion or repetitive visual patterns, so patients may dislike traffic, moving crowds, supermarket aisles, watching car chases in movies, ironing striped shirts or driving on motorways [5]. On the basis of the clinical experience of the authors, looking at a moving fan also trigger dizziness in VVM patients.

Different theories tried to explain the pathophysiology of VVM. Recently it was postulated that VVM occurs due to failure of reciprocal visual vestibular inhibition

mechanism which may occur due to an underlying vestibular abnormality [4].

VVM is difficult to diagnose because of a severe lack of specific investigation tools, a limited ability to measure the degree of dysfunction in these patients, and because there is a wide interindividual variability between the degree of dysfunction and intensity of symptoms [1]. Moreover, there are few researches that studied the visual vestibular interaction disorder despite the presence of a considerable number of patients complaining of symptoms suggestive of this dysfunction. Accordingly this study was conducted to explore these symptoms complex and the most appropriate tools for the identification of this dysfunction, if any.

Aim

To identify VVM disorder in dizzy patients and its relation to vestibular disorders.

Patients and methods

This study was conducted in the Audio-Vestibular Unit, Ain Shams Specialized Hospital and Ismailia General Hospital. In all, 30 patients suffering from symptoms suggesting a VVM were examined in the period from May 2012 to October 2014.

Inclusion criteria

The patient should have at least three positive answers for the following symptoms.

Patient feels unwell when:

(1) Going on an escalator.
(2) Watching traffic at an intersection.
(3) Being in a supermarket.
(4) Walking in a shopping mall.
(5) Seeing checkerboard floor pattern.

On the basis of the clinical experience of the authors, a sixth question was added in conjunction with the original Mallinson questionnaire.

(6) Looking at moving fans.

Patients on psychiatric treatment or bed ridden were excluded from this study.

Methods

Thirty patients were subjected to full neuro-otological history, vestibular assessment [in the form of office tests that include Fukuda stepping, functional reach, modified clinical test for sensory interaction of balance (MCTSIB) and dynamic visual acuity (DVA) test] and laboratory tests [in the form of cervical vestibular evoked myogenic potentials (cVEMPs) and videonystagmography (VNG)].

MCTSIB was done by counting the total time in seconds (four conditions) recorded for each patient and compared with the norms of Cohen *et al.* [6].

Functional reach test was done by measuring the distance between the start and end point and compared with the norms using the head of the metacarpal of the third finger as the reference point [7].

Vestibular lab tests were done including standard VNG using micromedical visual eyes searching for spontaneous, gaze-evoked and positional nystagmus, oculomotor test battery, together with the Dix-Hallpike test and bithermal caloric test. CVEMP was done using Bio-logic Navigator. It was recorded from sternocleidomastoid muscles, while the patient in the sitting position. The isometric muscle contraction was continuously monitored to allow continuous stable muscle contraction by placing active electrodes over the middle third of each sternocleidomastoid muscles with a reference electrode on the lateral end of the upper sternum while the common electrode was placed in the forehead [8].

P1, N1 latencies, P1N1 amplitude and the degree of asymmetry between both ears were measured and compared with the norms established by the same equipment at Ain Shams University.

Results

The prevalence of VVM patients among the dizzy population was19.6% (30 patients out of 153) according to the modified questionnaire in this study with female predominance (60%). The mean age of patients in the current study is 38.1±12.3 (year).

Table 1 shows that a sense of rotation is the most common complaint among patients of VVM.

20% of patients had associated migraine disorder while 14% of patients had motion sickness complaints.

Table 2 shows that dizziness when looking at moving fans (situation 6) was the most frequent complaint among the study group in 80% of patients.

Table 3 showed that the majority of the study group patients had abnormal office test results while 50% of patients had abnormal DVA test results.

Twenty-nine patients had abnormal MCTSIB test results, most of them had abnormality in the third and fourth condition.

On the other hand, only three patients showed a VNG abnormality in the form of canal asymmetry and one had associated posterior canal bengin paroxysmal positional vertigo (BPPV).

Table 4 shows that 50% of VVM patients had abnormal cVEMP test results.

Table 5 shows a statistically nonsignificant relation between complaints among the study group and different tests performed.

Discussion

Mallinson [1], developed a questionnaire for diagnosis of VVM patients based on the patients' sensitivity to certain conditions in their daily life.

Meanwhile, the authors modified the questionnaire by adding a sixth question based on their clinical experience which was looking at a moving fan. The use of fan is a tradition and frequently encountered to adapt to hot climate in summer in Egypt and some other countries; 30 patients were selected for the current study based on the modified questionnaire.

Table 1 Breakdown of patients' main complaints

Complain	*n* (%)
Imbalance/unsteadiness	7 (23.3)
Oscillopsia	5 (16.7)
Sense of rotation	13 (43.3)
Light headedness	5 (16.7)
Total	30 (100)

Table 2 Breakdown of visual vestibular mismatch questionnaire

Visual vestibular mismatch questionnaire	Positive [*n*/*N* (%)]
Going on an escalator (situation 1)	16/30 (53.7)
Watching traffic at an intersection (situation 2)	17/30 (56.7)
Being in a supermarket (situation 3)	18/30 (60)
Walking in a shopping mall (situation 4)	19/30 (63.3)
Seeing checkerboard floor pattern (situation 5)	17/30 (56.7)
Looking at a moving fan (situation 6)	24/30 (80)

They were18 women and 12 men (mild female dominance) with a mean age 38.1±12.3 years.

Patients had various descriptions for their dizziness complaint but a sense of rotation beside the visually induced dizziness was the most prevalent complaint among the study group (Table 1). This agrees with the statement of Mallinson [1] who found that VVM symptoms can occur in isolation or in conjunction with the commonly accepted symptoms of vestibular disorders.

According to the VVM questionnaire, looking at moving fans was shown to be the most sensitive question in the modified questionnaire (80% of patients developed dizziness when looking at moving fans); on the other hand, 63.3% of patients felt dizzy in malls and 60% of patients also felt dizzy in supermarkets (Table 6). Bronstein [9] found that the most precipitating factors for dizziness was walking in supermarkets (six out of 15 patients), visual moving surrounding during travelling (five patients), moving objects such as disco lights, people walking, cars passing (six patients) and movement of the eye (two patients).

Mallinson [1] stated that the VVM set of symptoms parallels motion sickness so closely, the suggestion made is that they share a common origin [10].

In the current study, 20% of the study group had a history of migrainous attacks and 13.3% had complained of motion sickness. It was believed that the symptoms of VVM would have a higher frequency

Table 3 Office test results in patients with visual vestibular mismatch

Office test	Normal [*n* (%)]	Abnormal [*n* (%)]
Fukuda	23 (76.66)	7 (23.33)
Dynamic visual test	15 (50)	15 (50)
Functional reach test	22 (73.33)	8 (26.66)
Modified clinical test for sensory interaction of balance	1 (3.33)	29 (96.66)

Table 4 Cervical vestibular evoked myogenic potential test results in visual vestibular mismatch patients

Cervical vestibular evoked myogenic potential	*n* (%)
Normal	15 (50)
Bilateral absent waves	7 (23.3)
Unilateral absent waves	4 (13.3)
Delayed latencies	4 (13.3)
Total	30 (100)

Table 5 Effect of complaint on patients' results in questionnaire, office tests and vestibular test battery

Results	Value	*d.f.*	*P* value
Modified questionnaire	0.4	2	0.819
Videonystagmography	0.136	1	0.713
Cervical vestibular evoked myogenic potential	1.707	3	0.635
Dynamic visual test	0.136	1	0.713
Modified clinical test for sensory interaction of balance	1.353	1	0.245
Functional reach test	0.151	1	0.697

Analysis of variance and χ^2-tests.

Table 6 Analysis of the modified visual vestibular mismatch questionnaire

Number of positive answers	3 Situation	4 Situation	5 Situation	6 Situation
n (%)	16 (53.3)	9 (30)	5 (16.7)	0 (0)

Distribution of patients according to their number of positive answers in the modified visual vestibular mismatch questionnaire.

of occurrence in patients who had head injury and/or whiplash type of injury. However, studies did not support this conjecture, as it was shown that the rate of newly developed VVM was 29% in vestibular patients who had a head blow; 30% in patients who did not suffer from head trauma and 36% in patients who had gentamycin intratympanic injection [1].

In this study, no patients had a history of head trauma, while four (13.3%) patients had a history of upper respiratory tract infection prior to the onset of dizziness complain. It was believed that the incidence of upper respiratory infection leading to vestibular neuritis prior to the development of vestibular symptoms varies from 23 to 100% [11].

This study used vestibular office tests to assess the vestibular system as it is simple, rapid and inexpensive procedures; functional reach test as a quick screen for determining risk of falls, Fukuda stepping test to examine vestibulospinal reflex and can help to determine the weaker labyrinth by the direction of rotation of the patient during walking. MCTSIB is a four-condition test used to assess the dependence of the patient on somatosensory, visual and vestibular inputs for balance, while DVA was used to assess vestibulo ocular reflex (VOR) through active head movement in yaw plan [12–15].

In the current study, it is evident that patients with VVM tend to lose the ability of gaze stabilization while performing relatively high-frequency head movement. Several studies report that while performing DVA patients had significantly high scores towards the affected side as the patients required a slower head velocity to maintain visual acuity with movement towards the lesioned side [16].

CTSIB is inexpensive and a useful option for clinics in which expensive dynamic posturography testing equipment is unavailable, but where the therapists still need objective data about balance and assess conflicts between vestibular system and other sensory systems as vision [17]. In this study almost all patients showed abnormal MCTSIB test especially conditions 3 and 4. This reflects the inability of VVM patients to accurately utilize visual cues to maintain balance when other components of balance are altered.

On the other hand, VNG was only abnormal on 10% of patients; the three patients revealed unilateral canal paresis reflecting unilateral peripheral vestibular lesion. Moreover one patient had additional unilateral posterior canal BPPV. Similarly Guerraz *et al.* [18] have concluded that the majority of VVM patients had minimal affection or normal results on conventional vestibular test battery. These results also agree with Mallinson and Longridge [19] who stated that standard vestibular assessments are often not helpful in measuring the deficits of VVM patients'.

In this study cVEMP test results were abnormal in 50% of patients where 23.3% had bilateral absent waves, 13.3% had unilateral absent waves and 13.3% had delayed latencies. According to the VEMP results, we can conclude that otolith affection (saccule and/or inferior vestibular nerve) plays an important role in VVM. This conclusion agrees with the conclusions of Mallinson [1] that VVM in most cases is probably due to inner ear affection mainly otolith, as he excluded SCC due to the presence of normal caloric test results on most patients.

Saccular dysfunction could be an underlying cause that leads to VVM. Isolated or a combined saccular/utriclar or canal affection may be present. This will need further specific tests for utricle and canals function. Moreover, abnormalities detected concerned with otolith function may provide further information regarding the extent of pathological involvement, but do not reliably identify patients with increased functional disability [20].

Not uncommon, our study has shown that VVM is presented among dizzy population and it can be easily identified by using an easy and rapid questionnaire (six items). Office tests as DVA and MCTSIB are highly sensitive tests in VVM patients but more

research is needed to understand the correlations between these tests and VVM.

The current study also pointed out the importance of cVEMP test to delineate the underlying saccular dysfunction in VVM patients and the need for more extensive research to understand the exact role of saccule in VVM.

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Conflicts of interest
There are no conflicts of interest.

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