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Audiovestibular and radiological findings in patients with migrainous vertigo

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Abstract

*Objective:*To describe the audiological, vestibular and radiological profile of patients with migrainous vertigo. *Methods:* This is a prospective descriptive study of patients who presented with migrainous vertigo in a tertiary care institute over one year.All patients between the ages of twenty to sixty who presented between 2013 and 2014 with migrainous vertigo diagnosed according to Neuhauser's criteria were included in this study. The diagnostic intervention was audiovestibular tests and magnetic resonance imaging (MRI) of brain with gadolinium. The main outcome measures were types and degree of auditory and vestibular deficits; MRI findings in migrainous vertigo, and whether age at presentation and duration of symptoms affected these findings.*Results:*Of the 112 patients recruited, the overall female-to male ratio was 1.7: 1. On pure tone audiogram, 18 (16%) patients had sensorineural hearing loss and this was similar in age groups<41 and >40 years. Caloric abnormalities were seen in 64 (61.5%) patients and there was no significant difference in the younger versus older age groups. MRI abnormality was present in 24% and the commonest finding was deep white matter hyperintensities in the brain. In the <41 age group, there were 8/46 with headache < 7 years (17.3%) and 5/9 (55.5%) with headache for ≥7 years with MRI abnormalities, and this difference was statistically significant (Chi sq 4.14, p=0.041).
*Conclusions:*Both audiological and vestibular abnormalities were seen in migrainous vertigo patients and older age did not appear to be an additional risk factor for the presence of theseabnormalities. Deep white matter hyperintensities were the commonest abnormality found on MRI scans and longer headache duration was associated with higher chances of MRI abnormalities in younger people.

INTRODUCTION

Migrainous vertigo(MV)is now a well-known entity and the subjectof several research studies in the last decade.[1-4] This condition has recently been included in the International Classification of Headache Disorders (ICHD) beta version as a separate clinical condition.[5] Vestibular abnormalities are found in both migraine and MV; although vestibular dysfunction is more common in MV than in migraine without vertigo.[2,6] Both central and peripheral vestibular involvement has been found in patients with migraine and MV.[6]

Vestibular symptoms in MV can be positional or spontaneous. They have been described as a surrounding rotatory type, head rotatory type, light-headedness and imbalance. Duration of episodes can last from a few seconds to several days. The episodes of dizziness may or may not have a temporal association with the headache or aura. Symptoms of MV could be so varied it could mimic any other type of vestibular disease.[7]

Headaches usually precede vertiginous symptoms,hence many patients may have an earlier diagnosis of migraine. In some, when vertiginous symptoms come to the fore, the headaches become less frequent and less severe. In other groups of patients, headaches of significance earlier are replaced by vertigo; only a careful history may reveal the association.[7,8]

Ischaemic episodes caused by vasospasm of blood vessels supplying the inner ear and vestibular pathways seem to cause recurrent vertigo in MV and such repeated ischemia may cause permanent changes in the vestibular system. The sacculocollic pathway seems to be involved in people with MV.[9]

MV is an extremely disabling condition and manifests commonly in the most productive span of a person's life. Literature is not clear on thetype and prevalence of auditory abnormalities in MV. Although it is known that MV can manifest at any age, there seems to be a paucity of data on the

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presentation of this condition with its associated audiovestibular and radiological abnormalities in various age groups.

Hence, the aim of this study was to describe audiovestibular and radiological manifestations in MVattending the audiovestibular clinic in order to provide agreater understanding of the inter-relatedness of the two leading symptoms of MV, and hence formulate better management strategies for this condition.

METHODS

This was a prospective study carried out in the audiovestibular clinic of a tertiary care academic hospital from first March 2013 to the end of February 2014.After clearance from the institutional review board, all patients between the ages of 20 to 60years who presented to the clinic withMV according to Neuhauser's criteria were included in this study (Table1).[8] Those with a history or findings of middle ear and inner ear diseases were excluded. These included tympanic membrane perforations, otitis media, otosclerosis, benign paroxysmal positional vertigo, ototoxicity and Meniere's disease.

All the patients included for the study underwent a detailed history and clinical otoneurological examination which included otoscopy, tuning fork tests, cerebellar function tests, head impulse test, tests for spontaneous and gaze nystagmus, saccades test, tests for skew deviation, smooth pursuit test, head impulse test, positional tests, tandem Romberg's test, cerebellar and gait tests. This wasfollowed by routine blood tests, pure tone audiometry (PTA), impedance audiometry (IA), electronystagmography (ENG), subjective visual vertical(SVV) and horizontal(SVH) and magnetic resonance imaging (MRI) brain with gadolinium. All patients were evaluated during the inter-ictal period of their MV episodes.

PTA was carried out using GSI--61, clinical two channel audiometer from Grason-Stadler, USA, MA-53 audiometers, MAICO Diagnostic GmbH, USA. Hearing loss was graded using the American Speech and Hearing Association guidelines.[10] IA was carried out using Siemens SD-30 and classified using Jerger's classification of tympanogram types.[11] ENG was done using computerized digital Electronystagmography Nystagmorite Mark II, Recorders and Medicare Systems (P) Ltd. 2007-–2008. Central vestibular pathology was diagnosed with the presence of saccadic intrusions of smooth pursuit, asymmetric optokinetic tests, prolonged direction changing positioning nystagmus and gaze evoked nystagmus. Bithermal caloric tests were carried out in the standard way

Table 1: Migrainous vertigo criteria proposed by Neuhauser*et al*[8]

Proposed diagnostic criteria for migrainous vertigo
Definite migrainous vertigo
A. Recurrent episodic vestibular symptoms of at least moderate severity*
B. Current or previous history of migraine according to the criteria of the International Headache Society
C. One of the following migrainous symptoms during at least two vertiginous attacks; migrainous headache, photophobia, phonophobia,visual or other auras
D. Other causes ruled out by appropriate investigations
Probable migrainous vertigo
A. Recurrent episodic vestibular symptoms of at least moderate severity
B. One of the following:
1. Current or previous history of migraine according to the criteria of the International Headache Society
2. Migrainous symptoms during≥2 attacks of vertigo
3. Migraine precipitants before vertigo in more than 50% of attacks: food triggers, sleep irregularities, hormonal changes
4. Response to migraine medications in more than 50% of attacks
C. Other causes ruled out by appropriate investigations
*Vestibular symptoms are rotational vertigo or other illusory self or object motion. They may be spontaneous or positional, or may be provoked or aggravated by head motion (head motion intolerance). Vestibular symptoms are moderate if they interfere with but do not prohibit daily activities and are severe if patients cannot continue daily activities.

using 20ml of water at 44 degree C and 30 degree C for irrigation to each ear over 30 seconds. Hypofunctioningand hyperfunctioninglabyrinth was diagnosed according to Claussen's butterfly chart andsum of the slow phase velocity of all 4 calorics (<20°/s-hypofunctioning, >140°/s-hyperfunctioning). Suppression of nystagmus in one direction was considered suggestive of central brainstem pathology.[12]SVV and SVH testing was done usingthe software from SVV equipment, (MUS_VS-V1.3.2.Rev B) Synapsis Company-France. Normal SVH was considered (-0.4±1.2).[13]An MRI brain with contrast wasalso done for these patients to rule out any significant central diagnosis.

The main outcome measures were the description of type and duration of symptoms with degree and laterality of hearing loss, types of vestibular defects and radiological abnormalities associated with MV.

RESULTS

There were 112 patients recruited into this study, 42(37.5%) were males and 70(62.5%) were females. The overall mean age was 39.7 years; mean age of males was 38.5 years and females, 40.5 years. The overall female to male ratio was 1.7:1.

Prior history of headache ranged from 3 months to 25 years (mean 4.6 years, median 3 years) and history of vertigo ranged from 3 months to 20 years (mean 2.7 years, median 2 years). The mean duration of headache and vertigo in the age groups <41 (3.7 and 2.8 years respectively) and > 40 years (5.5 and 2.6 years respectively) was similar and there was no significant difference. Headache preceded vertigo by an average of 1.2 years in the <41 year age group and by 2.9 years in the >40 year age group. In four patients of the older age group, vertigo preceded headache by an average of 8.5 years.

There was no difference in audiometric abnormalities between males and females. On PTA, 18 (16%) patients had sensorineural hearing loss (9 unilateral and 9 bilateral). Sensorineural hearing loss was similar in both age groups; 8(13.3%) in the <41 and 10(19.2%) in the >40 years and this difference was not significant (chi square 0.7, p=0.3). Five in the younger group had unilateral hearing loss (2 mild, 1 moderate, 1 severe and 1 profound) and 3 had mild bilateral hearing loss. In the older group, 4 had unilateral hearing loss (1 mild, 2 moderate and 1 profound), 6 had bilateral hearing loss; 4 mild and 2 moderate. There was no significant difference in the distribution of the mild and moderate (unilateral + bilateral) and the severe and profound (unilateral + bilateral) between the two age groups (Fishers exact test p=0.55) (Table 2).

Saccadic intrusions of smooth pursuit suggestive of central vestibular defects were seen in 4 patients (2 of younger group and 2 of older group). Peripheral type of spontaneous nystagmus was seen in 3 patients of the younger group.

Caloric abnormalities were seen in 64 (61.5%) patients out of 104 who underwent the test and this was similar in both age groups. There were 25 who had unilateral hypofunction and 29 who had bilateral hypofunction. In the younger group, 39 had abnormal caloric findings.Thirty five patients (90%) had unilateral or bilateral hypoactive findings and 4 (10%) with central

Table 2: Abnormal audiometric finding of the two age groups and the level of hearing loss

		Unilateral	Bilateral	Total
Age group 20-40 years (8) 44.4%	Mild	2	3	6 (33.3%)
	Moderate	1	0	
	Severe	1	0	2 (11.1%)
	Profound	1	0	
Age group 41-60 years (10) 55.6%	Mild	1	4	9 (50%)
	Moderate	2	2	
	Severe	0	0	1 (5.6%)
	Profound	1	0	
Total		9	9	18 (100%)

Table 3: Abnormal caloric responses of the two age groups. 'Central' denotes suppression of nystagmus direction

	Unilateral hypoactive	Bilateral hypoactive	Central	Unilateral hyperactive	Bilateral hyperactive	Total
Age 20-40 years	14 (35.8%)	21 (53.8%)	2 (5.1%)	1 (2.5%)	1 (2.5%)	39
Age 41-60 years	11 (44%)	8 (32.0%)	2 (8.0%)	0 (0%)	4 (16.0%)	25
Total	25 (39.1%)	29 (45.4%)	4 (6.2%)	1 (1.6%)	5 (7.9%)	64 (100%)

or unilateral or bilateral hyperactive findings and in the older group, 25 had abnormal caloric findings. Nineteen patients (76%) had unilateral or bilateral hypoactive findings and 6 (24%) with central or unilateral or bilateral hyperactive findings. This difference was not significant (Chi square 1.26, p=0.26). One patient in the younger group had unilateral hyperactive caloric responses and 4 in the older group had bilateral hyperactive responses; 2 in each of the age groups had suppression of nystagmus directionality suggestive of a central vestibular lesion (Table 3).

MRI on 86 of the 112 patients revealed 65 (76%) patients were normal while there were abnormalities in 21(24%), 13 were in the younger age group and 8were in the older group (chi square 0.05, p=0.8). The abnormal MRI findings are outlined in Table 4. The commonest was diffuse or linear T2/ FLAIRhyperintensities in the deep white matter of brain in both supra/infra-tentorial regions. Nine (10.5%) had this abnormality; 6were in the younger group and 3 in the older group. Deep white matter hyperintensities (DWMH) were described as diffuse, linear, patchy, long, small and cloaking type. The regions where these were present were corona radiata of frontal lobes, subcortical locations of frontal lobes, parietal region, putamen and claustrum, periventricular region, inferior frontal gyrus, inferior cerebellar lobes, hippocampus and peritrigonal areas. Lacunar infarcts in the thalamus and hypothalamus regions were noted among 2 in the younger group and in one in the oldergroup.

There was no significant difference in MRI abnormalities and years of headache. Chi sq for trend 2.00, p=0.15. In the 55 younger cases (<41 years) with headache and MRI, there were 8/46 with headache <7 years (17.3%) and 5/9 (55.5%) with headache for >7 years with MRI abnormalities. This difference was significant (Chi sq 4.14, p=0.041).

Among the 31 older patients (≥41 years)

Table 4: Description of magnetic resonance imaging (MRI) abnormalities in the 21 cases with MRI findings

MRI findings	Number	%
Deep white matter hyperintensities	9	42.9
Chronic lacunar infarcts	3	14.3
Cerebellar atrophy	2	9.5
Attenuated basilar artery	1	4.8
Small venous anomaly right cerebellar hemisphere	1	4.8
Gliosis bilateral basifrontal region	1	4.8
Small left frontal meningioma	1	4.8
Neurodegenerative changes with iron deposition	1	4.8
Petechial hemorrhagic focus left frontal lobe	1	4.8
Pineal cyst	1	4.8
Total	**21**	**100**

Table 5: Normal and abnormal MRI findings and duration of headache

Years of headache	Abnormal MRI	Normal MRI	Total	χ^2-distribution	P value
⩽1.5 years	6 (28.5%)	15 (71.4%)	21		
1.6 to 3 years	3 (11.5%)	23 (88.5%)	26		
3.1 to 6.9 years	2 (10.5%)	17 (89.5)	19	2.03	0.154
⩾7 years	10 (50%)	10 (50%)	20		
Total	21	65	86		

with headache and MRI, there were 3/20 (15%) with headache < 7 years and 5/11 (45.4%) with headache ≥7 years with MRI abnormalities (Table 5). This difference was not significant (Chi sq 2.03, p=0.154).

There was no significant difference in MRI abnormalities and years of vertigo. Chi sq for trends 1.89, p=0.17. Among the 55 younger cases (<40 years) with vertigo and MRI, there were 7/41 (17.1%) with vertigo for 3 years or less and 6/14 (42.8%) with more than 3 years of vertigo and MRI abnormalities. This difference was not significant (Chi sq 2.5, p=0.11). In the 31 older patients (≥41 years) with vertigo and MRI, there were 6/24 (25%) with vertigo 3 years or less and 2/7 (28.5%) with vertigo for >3 years with MRI abnormalities. This difference was not significant (Chi sq 0.09, p=0.76) (Table 6).

DISCUSSION

The pathophysiology of MV is still incompletely understood. We sub classified our study group based on the median age as young and older adults in order to determine if audiovestibular and radiological manifestations differed in these two age groups. In both age groups there was no significant difference in the duration of headache or vertigo suggesting that MV which commonly manifests with headache and vertigo does not have an age predilection. Also we found no difference in the sex distribution, audiometric, vestibular and radiological abnormalities between these groups.Vertigo manifests typically a few years after the onset of headache symptoms and this pattern seems to follow irrespective of the age of onset of MV.

Though vestibular symptoms in MV have been studied in greater detail, audiological aspects of MV are still poorly reported. Recent references on MV and Meneire's disease have postulated that recurrent ischaemic episodes during vasospasm in migrainous episodes may lead to development of permanent cochleovestibular changes including endolymphatic hydrops.[14] Sudden profound hearing loss has been known to occur in migraine disorders and fluctuating hearing loss in MV.[15,20] Our study shows that hearing loss in MV could be unilateral or bilateral and could range from mild to profound degree. It also appears that hearing loss is not related to older age at presentation. Audiometric abnormality was found in 16% of our patients. In a retrospective study by Battista, audiometric abnormality was found in 3% of patients with migraine related auditory- vestibular dysfunction. They reported a unilateral or bilateral loss of mild to moderate degree. Their diagnosis of migraine related auditory-vestibular dysfunction was not based on Neuhauser's criteria for MV but rather on the International headache society (IHS) criteria for migraine, with or without aura along with 3 definite episodes of vertigo. Being a retrospective chart review, there may have

Table 6: Normal and abnormal MRI findings and duration of vertigo

Years of vertigo	Abnormal MRI	Normal MRI	Total	χ^2-distribution	P value
< 1 year	7 (18.9%)	30 (81%)	37		
1.1 to 3 years	6 (21.4%)	22 (78.6%)	28	0.09	0.76
> 3 years	8 (38.1)	13 (61.9%)	21		
Total	21	65	86		

been inadvertent exclusion of patients because of misclassification since Neuhauser's criteria for diagnosis of MV were not used.[15]

Vestibular evaluation of MV patients during the inter-ictal phase has been found to be clinically non-significant and the diagnosis as such is not based on physical examination but on careful history taking.[2]Our study also confirms this observation. The majority of vestibular deficits found in our study were of the peripheral type and caloric hypofunction was the commonest abnormality found. Central features found in vestibular testing were saccadic intrusions of smooth pursuit, hyperactive caloric responses and directional preponderance. Some earlier studies have found a predominantly peripheral type of vestibular deficit[21],others, a largely central type of vertigo[7] while in others an equal distribution of both central and peripheral vestibular deficits.[2]Thepathophysiology of vestibular defects appears to be due to vasospasm of arteries supplying vestibular end organs and brainstem vestibular nuclei. This could therefore lead to a central/peripheral or mixed vestibulopathy depending on which arteries are affected during a migrainous episode. Chronic repeated ischaemia leads to permanent vestibular defects which could be unilateral or bilateral in nature. This can lead to partially compensated vestibular pathologyin MV and possibly explains the positive role of vestibular rehabilitation in MV.[22]

Auditory problems are much less frequently associated in MV (16% in our study as compared to 61.5% of caloric abnormalities) and the mechanism of vasospasm and chronicischaemia fails to explain this difference adequately. Other mechanisms may be involved in the manifestation of vestibular symptoms in MV than just ischaemia of vestibular pathways and end-organs. Cortical spreading depression and role of neuropeptides which play a neuro-modulatory role in both central and peripheral vestibular pathways may explain this discrepancy.[9]

DWMH were the commonest type of MRI findings, in 9(42.9%) out of 21abnormalities. This finding has been described in migraine patients but never in MV.The pathophysiology of DWMH is thought to be due to chronic cerebrovascular ischaemic changes. One study reported an increasing age, family history of migraine and increasing headache frequency as predisposing factors for this radiological finding.[23] Others suggest that earlier onset of disease is a risk factor for DWMH.[24]Our study shows thatduration of headache is significantly associated with probability of radiological abnormalities inyounger age group;however our numbers were small and this association was not present in the older age group or withthe duration of vertigo.A larger number of younger patients, 6(28.6%) had DWMH but this could have been by chance. Converselyolder age/later onset of MV does not seem to be an additional risk factor for developing DWMH. Both sexes had equal distribution of this MRI finding (5 males and 4 females). A study done on a cohort of older participants (>65 years) from a large cardiovascular health study suggested that white matter hyperintensities and silent strokes were significantly related. Neurological findings like gait abnormalities and cognition defects were significantly associated with higher grades of DWMH.[25]

DWMH in MV can manifest at younger ages as suggested by this study. Hence it becomes an important investigation in such patients for management. The role of prophylactic medication suchas flunarizinewhichreduce symptoms in MV[26] requires further investigation to see if it prevents the formation of DWMH.

In conclusion, audiological abnormalities were present in 16% and caloric abnormalities were present in 61.5 % of MV patients and presentation of disease at an older age did not appear to be an additional risk factor for the presence of these abnormalities. DWMH were the commonest abnormality found onMRI scans of these patients and older age did not appear to predispose to the development of this finding. Years of headache were associated with higher chances of MRI abnormalities in younger people.

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