

Original Research Article

Vestibular test and electronystagmography in the diagnosis of vertigo

Zorengpuii¹, Naveen P.^{2*}

¹Department of Otorhinolaryngology, State Referral Hospital, Falkawn, Aizawl, Mizoram, India

²Department of Physiology, Zoram Medical College, Falkawn, Aizawl, Mizoram, India

Received: 09 September 2019

Accepted: 24 September 2019

*Correspondence:

Dr. Naveen P.,

E-mail: naveenphysiol@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Vertigo, by definition, is a subjective sense of imbalance, and can result from a variety of disorders both peripheral and central. Although perfect function is required for precise balance and eye movement control, man is able to function adequately with only two of the three main sensory inputs. Great difficulty, however, occurs if only one system is intact, or if the control integrating mechanisms within the nervous system are deranged. Minor deficiencies of any, or all three sensory inputs may give rise to symptoms of imbalance. The disorders causing vertigo may be of peripheral or central origin, and accurate diagnosis of the underlying pathology is warranted for effective treatment.

Methods: The study was carried out in the Department of Otorhinolaryngology, Regional Institute of Medical Sciences, Imphal. 50 cases presenting with symptoms of vertigo were studied irrespective of age, sex, caste, religion, socio-economic status and duration of illness. They were subjected to a thorough clinical examination and relevant investigations with main emphasis on vestibular tests and electronystagmography in every patient.

Results: Vertigo of peripheral and central lesions accounted for 64% and 12% respectively. Idiopathic vertigo in which no neurotological abnormality is detected accounted for 24% of cases. Meniere's disease (28%) comprised the single largest group amongst the peripheral vertigo. Majority of the patients (58%) presented with hearing impairment as associated symptom.

Conclusions: Ninety percent of patients presented with less than one year duration of vertigo. Vertigo caused by peripheral vestibular lesion presents as acute, unprecipitated, short-lived episodes associated with nausea and vomiting, while vertigo of central vestibular origin follows a more gradual and insidious onset of continual imbalance.

Keywords: Electronystagmography, Vestibular tests, Balance, Vertigo

INTRODUCTION

Vertigo is a symptom of multi-systemic disorders of various etiological factors with different clinical manifestations. Balance is a complex sensorimotor task involving accurate and redundant sensory input from the visual, vestibular and proprioceptive systems, central nervous system integration of the sensory signals and the generation of the appropriate motor commands and adequate musculoskeletal capabilities to perform the motor tasks involved in oculomotor and posture control.

Vertigo is derived from the Latin word "vertere", it means to turn; implies a sensation of turning. It may be defined as a hallucination of movement or subjective sense of imbalance.^{1,2} Basically, vertigo can be described as rotatory or unsteady. If it is rotatory, patients usually have little difficulty in saying so. If it is unsteady without any obvious sense of rotation, patients have more difficulty in giving a good description and many will have associated symptoms such as deafness, tinnitus, nausea or vomiting. Each of these two groups (rotatory or unsteady) can be further subdivided into those where the

symptom is episodic and those where it is more or less continuous. In episodic type, the vertigo may be very short-lived and may last for less than a minute, or very much longer, such as hours or days.

Vertigo may be of central, peripheral or mixed. According to Hood, an important feature of any neurotological investigation of vertigo is the examination of the eyes for spontaneous nystagmus or for some derangement of induced nystagmus.³ Nystagmus is a disturbance of ocular posture, characterized by a more or less rhythmical oscillation of the eyes. Depending upon the appearance of the movements, nystagmus is categorized into two types pendular nystagmus, characterized by ocular oscillations that are approximately equal in velocity in both directions and are almost always horizontal and phasic or jerky nystagmus, characterized by rhythmic oscillations in which the movement in one direction is significantly faster than in the other.²

The principal purpose of balance function studies is to localize the site of the lesion and to estimate the extent of the lesion which can be helpful in management of the patient and in confirming the suspected diagnosis. One of the most important examinations for the patient with vertigo is the vestibular test. The vestibular examination is to find out the integrity of the vestibulo-ocular and retino-ocular system. Among the vestibular tests, traditional Hallpike-Fitzgerald caloric test, Dundas Grant method test and rotational test have been replaced by electronystagmography due to their limited diagnostic value.

Electronystagmography (ENG) is no longer considered to be an experimental device. It is now accepted as a routine investigation in the diagnosis and management of patients suffering from vertigo and equilibrium disorders. The method was first proposed by Schott in 1922 and was applied clinically by Jung in 1939. ENG can differentiate between central or peripheral causes of vertigo. The technique of electronystagmography depends on the potential difference between the cornea and retina, created by the retinal pigmentary epithelium. The pigmented layer of the retina maintains a negative potential with respect to the rest of the eye by means of active ion transport. The eyeball behaves as a dipole with its axis coinciding with the optical axis of the eye. An electrode placed lateral to the eye becomes more positive when the eye rotates towards it and more negative when it rotates away, with reference to an electrode at a more remote location. The voltage change represent the change in eye position as only small angular movements are involved in nystagmus and the relationship between voltage change and the eye movement is virtually linear at these small degrees of arc.⁴ The electric potentials are greatly amplified and recorded directly on a running strip of paper by an apparatus called electronystagmogram.⁵ Even electric potential of 2 mv can be recorded and a nystagmus beat of 2 mm or more is significant. The

technique of electronystagmography has the advantage of supplying a graphic record of the nystagmus for immediate, delayed and repeated examination and also allows comparison and contrasting of the nystagmus with the eyes open and with the eyes closed.

Rubin, in a review of seventeen years' experience, says: "No patient with a complaint of disequilibrium or sufficiently evaluated without an ENG recording of balance function".⁶ ENG testing is comprised of calibration, gaze test, caloric test, smooth pursuit test and random saccade test. ENG record also can be used for medico-legal purposes. By calculating maximum slow phase velocity and culmination frequency from ENG, directional preponderance and canal paresis can be found out.

The aim of the present study was to find out the causes of vertigo of vestibular origin using ENG and to establish the diagnosis in vertigo of peripheral and central origin.

METHODS

The study was conducted in the Department of Otorhinolaryngology in Regional Institute of Medical Sciences, Imphal, Manipur. Ethical committee approval was taken before carrying out the study. The study was conducted between October 2002 to October 2004. A total of 50 cases presenting with symptoms of vertigo attending outpatient department of otorhinolaryngology and those admitted in the wards were studied irrespective of age, sex, caste, religion, socio-economic status and duration of illness. Thorough clinical examination and relevant radiological investigations were performed in all the cases. Detailed history of each patient including medical history with special reference to audio-vestibular symptoms were taken.

Inclusion criteria

50 cases with symptoms of vertigo.

Exclusion criteria

Smokers, alcoholics, patients on antihistaminic and antiemetic drugs.

All the cases underwent Vestibular test, Romberg test, Unterberger's/Fakuda stepping test, Gait test and Fistula test.

ENG test was done on all cases. The patients subjected to undergo this test were abstained from alcohol, sedatives, hypnotics, antihistaminics, any anti-vertigo medications 48 hours prior to evaluation. The external auditory canals were examined for wax, discharge, infection, perforation of the tympanic membrane or an operated mastoid cavity. The test was performed with eyes opened in a dark room. A series of subtests: Pendulum tracking test, positional

test, Dix-Hallpike test, bithermal caloric test was performed with the help of an electronystagmograph.

Placing of electrodes

The electrodes used were made of silver, coated with non-polarizing silver chloride. The electrodes were firmly applied with the help of lead free adhesive tapes and electrolyte paste was used to ensure proper conduction and to keep the electrodes-skin resistance to a minimum. The electrodes were applied to the skin over the forehead, 1.5 to 2 cm lateral to outer canthi, and above and below the left eye.

The data collected was analysed using statistical package for social services (SPSS 20). The categorical variables were presented as percentages using Microsoft excel. Microsoft word was used to generate tables.

RESULTS

The maximum number of patients is those in service (38%), followed by housewife (28%), businessman or woman (22%), student (8%) and farmer (4%).

Table 1: Distribution of patients with vertigo according to occupation.

Occupation	No. of cases	%
Service	19	38
Housewife	14	28
Businessman or woman	11	22
Student	4	8
Farmer	2	4

Table 2 shows distribution of patients according to duration of vertigo. The maximum number of patients 18 (36%) had vertigo between 1 week to 1 month.

Table 2: Duration of vertigo.

Duration	No. of cases	%
<1 week	12	24
1 week to 1 month	18	36
1 month to 6 months	9	18
6 months to 1 year	6	12
1 year to 2 years	4	8
2 years to 5 years	1	2

Table 3 shows associated symptoms in patients with vertigo. Impairment of hearing is seen in 29 (58%) patients, tinnitus in 28 (56%) patients, vomiting and nausea in 27 (54%) patients, headache in 12 (24%) patients, diplopia in 2 (4%) patients, epistaxis in 1 (2%) patient, numbness of face in 1 (2%) patient and loss of vision in 1 (2%) patient.

Table 3: Distribution of cases according to associated symptoms.

Symptoms	No. of patient	%
Impairment of hearing	29	58
Tinnitus	28	56
Vomiting and nausea	27	54
Headache	12	24
Diplopia	2	4
Epistaxis	1	2
Numbness of face	1	2
Loss of vision	1	2

Table 4: Findings of vestibular test and ENG.

Test	No. of patient	%
Romberg test positive	21	42
Unterberger or Fukuda stepping test positive	18	36
Gait test positive	6	12
Fistula test positive	0	0
Electronystagmography positive	38	76

Table 4 shows findings of vestibular test. Romberg test was found to be positive in 21 (42%) patients, Unterberger or Fukuda stepping test positive in 18 (36%) patients and Gait test was positive in 6 (12%) patients. Electronystagmography was positive in 38 (76%) patients and found to be most sensitive among the diagnostic parameters used in diagnosis of vertigo.

Table 5: Distribution of site of lesion in 50 cases with vertigo.

Level of lesion	No. of patient	%
Peripheral causes	32	64
Central causes	6	12
Idiopathic vertigo	12	24

In the present study, vertigo due to peripheral causes accounted for 32 (64%) cases and central causes accounted for 6 (12%) cases. 12 (24%) of the cases presented with vertigo but they did not show any neurological abnormality on investigations and was labelled as idiopathic vertigo.

Table 6: Distribution of cases with peripheral disorders.

Type of disorders	No. of patient	%
Meniere's disease	14	28
Benign paroxysmal	12	24
Positional vertigo		
Vestibular neuronitis	4	8
Acute labyrinthitis	2	4

Amongst the peripheral disorders which accounted for 32 (64%) of all the cases, Meniere's disease (28%) formed the most common cause of vertigo followed by benign paroxysmal positional vertigo (24%), vestibular neuronitis (8%) and acute labyrinthitis (4%).

In the study, 6 (12%) cases were diagnosed as central disorders amongst which hypertension accounted for 2 (4%) cases, diabetes mellitus 1 (2%) of case, tuberculoma in vermis of cerebellum and right frontal lobe 1 (2%) case, intraventricular hemorrhage 1 (2%) case and bilateral acoustic neuroma with multiple meningiomas with hydrocephalus 1 (2%) case, as shown in table 7.

Table 7: Distribution of cases with central disorders.

Type of disorders	No. of patient	%
Hypertension	2	4
Diabetes mellitus	1	2
Tuberculoma in vermis of cerebellum and right frontal lobe	1	2
Intraventricular hemorrhage	1	2
Bilateral acoustic neuroma with multiple meningioma with hydrocephalus	1	2

DISCUSSION

Vertigo is a symptom of multi-systemic disorders of various aetiological factors with different clinical manifestations. In this study, 50 cases of vertigo were studied in order to find out the causes of vertigo, peripheral and central origin by using different diagnostic parameters with main emphasis on ENG and vestibular tests. In the study, the largest group comprised of those who were in service 19 (38%) followed by housewives 14 (28%) (Table 1). Behl in a series of 50 cases of vertigo, observed housewives constituted the largest group.⁷ This disparity may be due to higher education and better information among people in the service and hence early consultation and treatment.

In the study, shorter duration of vertigo (<1 year) was seen in 90% cases and longer duration (>1 year) in 10% cases (Table 2). The duration of vertigo plays an important role in differentiating peripheral and central vertigo. Vertigo of shorter duration was observed in peripheral lesions and recurrent vertigo of longer duration was observed in central lesion. Gulati et al in their study of 50 patients reported similar observation.⁸ The commonest associated symptoms in our study was unilateral or bilateral impairment of hearing comprising of 29 (58%) cases. Tinnitus was seen in 28 (56%), nausea and vomiting in 27 (54%), headache in 12 (24%), diplopia in 2 (4%), epistaxis in 1 (2%) and loss of vision in 1 (2%) cases respectively (Table 3). Mishra et al in their study of 118 patients with vertigo found impairment of hearing in 56.77% of patients.⁹ Bower and Cotton

reported the incidence of hearing loss varied from 21-75%.¹⁰

In a study of 115 patients with vertigo, Mishra reported vestibular tests such as Romberg test and Unterberger's test positive in 72% and 96% patients respectively.⁹ This is in contrast with the present study in which Romberg test and Unterberger's test were found positive in 42% and 36% patients respectively (Table 4). These tests are non-specific and may not localize the site of lesion. Standard vestibular test may not produce abnormalities in chronic vestibular lesions. ENG done in all patients showed response in 76%. ENG is found to be the most sensitive diagnostic parameters of vertigo in the study. 76% patients showed positive ENG response, whereas other tests like Romberg test, Unterberger's test and Gait test were positive in 42%, 36% and 12% respectively (Table 4).

Jongkees et al found that out of 341 patients complaining of vertigo, 230 showed either spontaneous or positional nystagmus on ENG.¹¹ The ENG recordings make the task of differentiation of peripheral from central abnormalities more precise and easier. In peripheral lesions, the nystagmus, spontaneous or caloric, can be inhibited by visual fixation and enhanced by closure of the eyes. In central lesions, visual fixation either induces spontaneous nystagmus or enhances the caloric nystagmus, but closure of the eyes reduces both types of nystagmus.¹²

In the present study, vertigo due to peripheral causes accounted for 32 (64%) cases and central causes accounted for 6 (12%) cases. 12 (24%) of the cases presented with vertigo but they did not show any neurological abnormality on investigations and was labelled as idiopathic vertigo (Table 5). Barber reported the incidence of vertigo due to central pathology is about 10%.¹³ Bhatia and Deka, in their study of 330 cases found 25% of central disorders and 25% of cases were of idiopathic vertigo.¹⁴ ENG shows normal patterns in 95% of the cases. Detailed clinical evaluation reveals that about half of these patients do not actually have true vertigo and some of the cases have endocrinological disorders such as pre-menstrual tension or menopausal problem.

Amongst the peripheral disorders, Meniere's disease comprised a single largest group 28% followed by benign paroxysmal positional vertigo 24%, vestibular neuronitis 8% and acute labyrinthitis 4% (Table 6). Cawthorne reported the incidence of Meniere's disease ranged from 2.54-63.8%.¹⁵ Bhatia and Deka reported similar observation.¹⁴

Amongst the central disorders which accounted for 6 (12%) of all the cases, hypertension (4%) formed the common cause of vertigo followed by diabetes mellitus (2%) (Table 7). Saha et al opined that vertigo is a frequent complaint of patients suffering from hypertension.¹⁶ Various pathological processes

accompanying hypertension such as anoxia, acute infarction, or haemorrhage may be involved in triggering a disturbance in circulation to the inner ear impairing the supply of obligate nutrients to the peripheral vestibular end organ or central connections causing vertigo. Schuknecht found that chronic dizziness is a common complaint in patients with diabetes mellitus and may result from the associated vascular pathology in the peripheral labyrinth, 8th nerve or its central connections.¹⁷ Morrison reported that 5% of patients with eighth nerve tumour suffer paroxysmal attacks of vertigo, while 16% suffer momentary vertigo or dizziness on sudden head movements and 8% may suffer acute vestibular failure with or without hearing loss during the course of the disorder.¹⁸

CONCLUSION

Vertiginous disorders, central and peripheral origin are diagnosed more often if ENG is used. ENG was positive in 76% cases of vertigo. Due to the diverse etiology and various clinical manifestations, diagnosis of vertigo is difficult. Vestibular test parameters like Romberg test, Unterberger's test, Gait test have low specificity and sensitivity and do not indicate the site of lesion. ENG, by utilizing the change in corneo-retinal potential consequent upon the movement of the eye is a sensitive and accurate diagnostic procedure for vertigo of central and peripheral lesions.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Mawson SR, Ludman H. Vestibular disorders. Mawson's diseases of the ear. 5th ed. London: Edward Arnold Limited; 1988: 619-647.
2. Brown, Scott WG. Vertigo. In: Kerr A, ed. Scott-Brown's Otolaryngology. 6th ed. Oxford, London: Butterworth-Heinemann, Elsevier; 1997: 1-10.
3. Hood JD. Electronystagmography. J Laryngol Otol. 1968;68:167-83.
4. Davies RA, Savundra PA. Diagnostic testing of the vestibular system. In: Stephens D, ed. Scott-Brown's Otolaryngology. 6th ed. London: Butterworth-Heinemann, Elsevier; 1997: 1-40.
5. Kirtane MV. Electronystagmography, Clinical audio-vestibulometry. 3rd ed. In: Biswas A. Mumbai, India: Bhalani Publishing House; 2002: 109-147.
6. Rubin W. Electronystagmography a review of 17 years' experience. Ann Otol Rhinol Laryngol. 1975;84:541-3.
7. Behl R. Vestibulocochlear function tests in cases of cervical spondylosis presenting with vertigo. A thesis submitted for Master of Surgery (Otorhinolaryngology), Nagpur University, 1982.
8. Gulati M, Pagare RS, Jankwal M. Clinical study of vertigo. Indian Medical Gazette; 1992: 44-46.
9. Mishra SC, Sharma H, Saxena A, Bhatia N and Shukla GK. Neuro-otological profile of episodic vertigo. Indian J Otolaryngol Head Neck Surg. 1994;3:124-7.
10. Bower CM, Cotton RT. The spectrum of vertigo in children. Arch Otolaryngol Head Neck Surg. 1995;121:911-5.
11. Jongkees LBW, Maas JP, Philipszoon AJ. Practica Oto-rhino-laryngologica. 1962;24:65.
12. Nagabhyru AR. Electronystagmography and the diagnosis of a cerebellar tumour. J Laryngol Otol. 1979;93:719-23.
13. Barber H. Positional nystagmus. Otolaryngol Head Neck Surg. 1984;92:649-55.
14. Bhatia R, Deka RC. Clinical profile of cases with vertigo. Indian J Otolaryngol. 1985;34(4):144-6.
15. Cawthorne T. Vertigo. Br Med J. 1952;2:931-3.
16. Saha A, Mehra YN, Mann SBS, Sharma BK, Panda NK. Audiovestibular functions in essential hypertension. Indian J Otolaryngol Head Neck Surg. 1993;2(4):177-81.
17. Schuknecht HF. Pathology of the ear. Cambridge, Massachusetts: Harvard University Press; 1974: 386-388.
18. Morrison AW. Meniere's disease. In: Dix MR, Hood JD, ed. Vertigo. Chichester, UK: John Wiley and Sons Limited; 1984: 133-152.

Cite this article as: Zorengpuii, Naveen P. Vestibular test and electronystagmography in the diagnosis of vertigo. Int J Otorhinolaryngol Head Neck Surg 2019;5:1575-9.