

Role of Electronystagmography in Diagnosis of Secondary BPPV in Elderly Patients with Vertigo: A Retrospective Study

Sanjay Kumar Gupta¹ · Aparajita Upadhyay²  · R. K. Mundra²

Received: 8 June 2018 / Accepted: 5 July 2018
© Association of Otolaryngologists of India 2018

Abstract Elderly population is frequently affected by vertigo which affects their mobility and makes them vulnerable to fall and other morbidities. Often these patient visit neurologist and are often subjected to CT scan, MRI brain etc. to rule out a central cause of vertigo; whereas majority of these patients suffer from vestibular cause of vertigo. A schematic approach by detailed history, simple tests for vestibular functions like Dix Hallpike, supine roll and head impulse test give important clue to diagnosis. Often the diagnosis is benign paroxysmal positional vertigo (BPPV) which is treated by repositioning maneuver. There are often other vestibular causes which may be diagnosed by Electronystagmography (ENG), electrocochleography and other tests. This study was undertaken to study occurrence of secondary BPPV utilizing various parameters of ENG. The study group comprised of 131 patients from the neuro-otology proforma data base at ENT centre and vertigo clinic from January 2015 to December 2017. Inclusion criterion was male and female aged 51 years and above presenting with dizziness, imbalance, rotational vertigo, unsteadiness as the chief complaint. Exclusion criterion was BPPV relieved after Epley's maneuver, Otitis externa, acute Otitis media, Suppurative Otitis media, pre existing neurological condition and history of ear surgery. Neuro-otology Data obtained and the ENG findings were tabulated in the master chart and the observations interpreted and transferred to Claussen's butterfly chart. The

study group comprised of 58 male (44.27%) and 73 female (55.73%) with a male female ratio of 1:1.25. ENG exhibited 36 patients (27.49%) to have recurrent BPPV, 53 (40.45%) were found to have unilateral/bilateral canal paresis. Meniere's disease was diagnosed in 39 (29.77%) patients and brain stem pathology identified in 3 (2.29%) cases.

Keywords Vertigo · BPPV · Electronystagmography

Introduction

Vertigo is a common presenting complaint in an Otolaryngology clinic. Clinician often faces a diagnostic challenge as dizziness could be due to wide range of vestibular and non vestibular causes [1].

Chiarella and Cassandra [2] observed that high incidence of fall in elderly is due to vertigo, it is important to utilize the knowledge of diagnostic procedure like Dix Hallpike, supine roll etc. and subsequent treatment by repositioning procedures [3].

Result of previous studies indicate that idiopathic primary BPPV is the most commonly identified vestibular disorder [4], however it is likely that secondary BPPV may occur due to various inner ear diseases like Meniere's disease [5], Labyrinthitis [6], head trauma [7] and sudden sensory neural hearing loss [8] making many of these patients getting partial relief or being unresponsive to canal repositioning procedure.

Singh et al. [9] observed that vestibular function is diminished with advancing age and described it as Presbytonia similar to Presbycusis of reduced audiological function in older age. Abrol et al. [10] studied 10,000 dizzy

✉ Aparajita Upadhyay
draparaajita6@gmail.com

¹ Department of ENT, Index Medical College Hospital and Research Centre, Indore, M.P., India

² Department of ENT, MGM Medical College and MY Hospital, Indore, M.P., India

individuals and observed 11% patients in the age group 60–80 presented with vertigo.

There is evidence observed by Schweigart et al. [11] that with the age there is decreased function of peripheral vestibular receptors, resulting in compensation by increased sensory inputs from proprioceptors of neck, thus increase in cervico-ocular reflex which is normally weak in human.

Chu et al. [12] observed that patients with migraine had a twofold increased risk of also suffering from BPPV.

Various tests have been advocated for diagnosing the cause of vertigo; however, there is a lack of a definitive protocol which covers all aspects. A study was done by Maarsingh et al. [13] and presented a set of diagnostic tests for evaluating dizzy patients by conducting a Delphi procedure empanelled by international and national experts dealing with patients of vertigo. The test protocol of elderly vertiginous patient includes, patient history comprising of symptoms of vertigo, medical history, medications, and alcohol intake. Physical examination including pulse, blood pressure, test for orthostatic hypotension, auscultation of heart, examination of lower limbs, tendon reflexes, tandem gait, ENT examination, otoscopy, Dix Hallpike test and visual acuity. Few other tests included were Hemoglobin estimation, Random blood glucose, ECG, audiometry and Psychological questionnaire [13].

A detailed history and neuro-otological examination is mandatory to get a clue regarding etiology of vertigo. Vestibular function along with the proprioceptors and vision play a vital role along with their central connections with brain and is responsible to maintain the balance. Nystagmus is an important clinical sign of vertigo and may be defined as an involuntary movement of the eyeball, horizontal, vertical or rotatory, consisting of a slow movement towards one side followed by a quick return movement to midline [14].

Various investigations like ENG, Video Nystagmography (VNG), Audiometry and Electro cochleo-graphy, Vestibular evoked myogenic potential; CT scan and MRI with angiography of brain along with other relevant investigations facilitate the diagnosis of vertigo. ENG enables to measure and document various parameters like spontaneous nystagmus, gaze nystagmus, optokinetic nystagmus positional nystagmus, Pendular Eye Tracking Test (PETT) and bithermal caloric induced nystagmus [15]. Claussen established his butterfly chart for topographical representation of caloric responses using central culmination frequency with linear characteristics and normal ranges in a test chart containing graphic plot of caloric responses along with numeric measurements. The frequency of nystagmus in culmination phase is as sensitive a parameter as mean slow phase velocity with accurate and

simple estimation, thus utilized for evaluation in this study [16].

Kacker [17] observed that ENG gives an insight into the vestibular reflex arc and its connections with brain and facilitate the testing of integrity of function of brainstem.

Results of previous studies indicate that secondary BPPV is an important cause of dizziness in elderly population. Thus a retrospective study was undertaken to study the various co existing vestibular disorders along with BPPV. ENG parameters were utilized to identify the common butterfly patterns and corresponding vestibular disorder.

Materials and Methods

This retrospective study group comprised of 131 patients from the neuro-otology proforma data base. Inclusion criterion was male and female aged 51 years and above with dizziness, imbalance, rotational vertigo, unsteadiness as the chief complaint presenting at ENT centre and vertigo clinic from January 2015 to December 2017. Exclusion criterion was BPPV relieved with Epley's maneuver [18], Otitis externa, acute Otitis media, Suppurative Otitis media, history of ear surgery and pre existing neurological disorder.

A detailed history record was taken of all 131 patients with details including symptoms of vertigo, aggravating factors, relieving factors, duration of symptoms, frequency of symptoms, associated symptoms, history of Cardiac disorder, hypertension, Diabetes Mellitus, Thyroid disorder, Neurology disorder, whiplash injury, medication history, addiction, progress of symptoms. A detailed Ear nose throat examination, Neurology examination including examination of cranial nerves, finger nose test, Romberg's test, Unterberger stepping test, head impulse test, supine roll test and Dix Hallpike test were performed.

ENG records of all 131 cases were studied. ENG was performed after withdrawing labyrinthine sedatives for 48 h and keeping the patient fasting for 2 h prior to the test. Multi channel computerized ENG machine by RMS was used for ENG. The ENG graph obtained was studied and the central culmination frequency calculated for each test. The test results were noted on master chart and the spontaneous nystagmus and bithermal caloric test results were plotted on Claussen's Butterfly chart [16]. The responses coded as "0" for normal within the normal range of nystagmus beats, code "1" for response below the normal range and code "2" for response higher than the normal range. The code is then represented in the order of right warm, right cold, left warm and left cold giving a four digit code called the Trinary code [19]. Data was analyzed using IBM SPSS 20.0 version software.

Observations and Results

In this study of 131 cases 58 male (44.27%) and 73 female (55.73%) were included with a male:female ratio of 1:1.25. The present study indicate higher incidence of vertigo in female as compared to male with mean age of 61.03 in male and 60.75 in female, with standard deviation ± 7.17 and ± 6.80 respectively. Further the incidence of vertigo is high in the 6th decade of life (53.43%) in the study group (Table 1).

Positional nystagmus was observed in all 131 cases which was partially relieved or there was no change after performing an Epley's maneuver. The ENG patterns observed were "0000", "0002", and "0200" suggestive of recurrent BPPV in 36 patients (27.49%). Bilateral canal paresis in 34 patients (25.95%) with ENG patterns "1110", "1111", "1010", and "1011". Meniere's disease was diagnosed in 39 patients (29.77%) with ENG trinary code of "1101", "0111", "2000", "0101", "0001", "2011", "0100", "2021", "1120", "2111" and "2100". All the patient diagnosed as Meniere's disease were subjected to Electro Cochleo-graphy (EcochG) and the SP/AP ratio were elevated (> 0.5) in all the patients in the ear showing unilateral/bilateral cold hypo response or unilateral/bilateral warm cold dissociation in bithermal caloric parameter in ENG [15, 20]. Right canal paresis was observed in 10 patients (7.63%) with ENG pattern "1000", "1100" and "1120". Patient with left canal paresis were 9 out of 131 (6.87%) and Trinary code was "0010", "0011" and "2011". Inhibitory preponderance was observed in 3 patients (2.29%) with "0110" and "1001" patterns, suggestive of brain stem pathology, there was absence of visual fixation suppression and abnormal (Type IV) PETT (Table 2).

Discussion

In the present study of 131 cases 58 male (44.29%) and 73 female (55.75%) were included with a male:female ratio of 1:1.25.

Kirtane in 1979 studied 319 cases of vertigo and reported a male:female ratio of 1.77:1 including 204 males

and 115 females, with the prevalence of vertigo in second third and fourth decade of life [15]. Deka et al. [21] observed male female ration of 3:2 and BPPV to be the commonest disorder with incidence of 17% of peripheral vestibular disorders. Another study of 1455 patients by Kirtane et al. [22] observed a male:female ratio of 2.2:1 where age ranged from 21 to 75 years. Pipal et al. [23] studied 100 cases of vertigo and male female ratio was 1.27:1 with age of peak occurrence being third decade followed by second decade, only 3 patients above the age of 70 and none below the age of 10 years. As compared to previous studies, the present study exhibits BPPV in 22.03% patients with male female ratio of 1:1.25, exhibiting female predominance, could be explained due to better medical facilities and more awareness among female to seek treatment.

Kim et al. [24] have shown that BPPV is the most frequent diagnosis, 42% of all dizzy individuals. Jose et al. [25] observed BPPV is commonly associated with whiplash injury, vestibular neuronitis and cervical Spondylosis. This study supports observation of Thakar et al. advocating, repositioning maneuver in all cases of peripheral vertigo with continuing vertigo for more than 2 weeks is a useful protocol, thus confirming or excluding diagnosis of BPVV [26].

The largest group comprised of 53 (40.67%) patients out of 131, with unilateral/bilateral peripheral vestibular hypo response. Mundra et al. [27] observed in a study of 75 normal individual that Culmination frequency is 33% higher in the age group 51–60 years than 61–80 years. This explains the high incidence of unilateral/bilateral peripheral vestibular pathology and hypo response in caloric stimulation in this group.

Lee et al. [28] observed that idiopathic sudden sensory hearing loss (50.7%), Meniere's disease (28.9%) and unilateral vestibulopathy such as acute vestibular neuronitis and herpes zoster Oticus (20.2%) were associated with secondary BPPV; posterior canal being most commonly involved.

The present study observed vestibular cause in 97.71% cases and central cause in 2.29%. The high incidence of peripheral vestibular cause in this study can be justified by exclusion of pre existing neurological disorders from the study group. Further there is a tendency among vertiginous patient to have first consultation with neurologist and these patients consult Otolaryngologist after exclusion of neurological disorder.

Vestibular Rehabilitation exercises play a very important role in management of unilateral or bilateral vestibulopathy which formed the largest group of 40.45% in this study. Unfortunately the fall out rate is very high and follow up is not up to expectation of clinician, thus there are incidences of recurrence of vertigo. To create interest in

Table 1 Age wise male female ratio of patients with vertigo

Age groups in years	Male	Female	Total
50–59	31	39	70 (53.44%)
60–69	19	26	45 (34.35%)
70–79	8	8	16 (12.21%)
Total	58	73	131
Percentage	44.27	55.73	100

Table 2 Trinary codes observed in ENG and interpretation of vestibular/central disorder

Serial no.	Trinary code	Meniere's disease	Recurrent BPPV	Bilateral peripheral pathology	Unilateral peripheral pathology	Central pathology	Number of patients
1	0101	8					8
2	1101	7					7
3	0100	5					5
4	0001	1					1
5	2020	4					4
6	2100	2					2
7	0111	7					7
8	2000	1					1
9	2111	2					2
10	2021	2					2
11	1111			22			22
12	1010			4			4
13	1011			6			6
14	1110			2			2
15	0000		33				33
16	0002		2				2
17	0200		1				1
18	0010				6		6
19	0011				2		2
20	2011				1		1
21	1000				6		6
22	1100				3		3
23	1120				1		1
24	0110					2	2
25	1001					1	1
Total		39	36	34	19	3	131
Percent		29.77	27.48	25.95	14.50	2.29	

rehabilitation exercises among patients, Huang et al. proposed a series of virtual games adapted by Cawthorne-Cooksey exercises. In their study 32 patients participate in the rehabilitation processes. Within 2 months their gaming parameters and quantified balance indices exhibited improvement in 81% of their game parameters and balance indices. Patients also showed higher willingness and motivation to regularly perform rehabilitation with the proposed system [29].

Conclusion

The cause of vertigo in older age group is more often due to peripheral vestibular pathology. Bilateral peripheral vestibular dysfunction seems to be the most common cause of vertigo in this group. The high incidence of bilateral peripheral vestibular lesions 40.67% may be explained due to unnoticed or forgotten first episode of vertigo causing a

unilateral peripheral pathology which recover in 3–4 weeks. The patient is able to maintain balance by phenomenon of central compensation [19]. When the other vestibule of the patient is affected after an interval of few years he reports for treatment and is then diagnosed as having a bilateral vestibular pathology.

The observations in this study impress upon the importance and utility of ENG, as it was evident that out of 131 cases, all had positive Dix Hallpike test suggestive of BPPV. However after performing Epley maneuver [18] only 36 (27.48%) patients were relieved of vertigo, remaining 95 patients were unresponsive and continued to get vertigo. ENG exhibited 36 (27.48%) to have recurrent BPPV, 53 (40.45%) were found to have unilateral/bilateral canal paresis; a very common cause of vertigo in elderly is reduced vestibular function due to aging, causing severe imbalance (Fig. 1). Vestibular rehabilitation exercises are of great value for treating this entity.

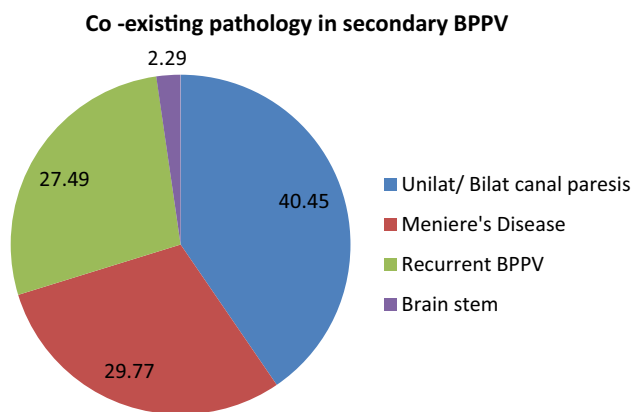


Fig. 1 Showing percentage of patients with co-existing peripheral/central pathology in secondary BPPV

Meniere's disease was diagnosed in 39 (29.77%) patients and brain stem pathology identified in 3 (2.29%) cases. All these cases required further evaluation and required different management. ENG parameters like Bithermal caloric test, gaze nystagmus, PETT and visual fixation suppression are very useful in identifying a peripheral or central cause of vertigo. These should be included in all vertigo protocol and should be performed before a CT scan or MRI of brain.

A detailed neuro-otology proforma in a standard format including history and oto-neurology examination is essential and recommended to have a national data base for further research on vertigo.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures in study involving human participants are in accordance with ethical standards of the Institutional and/or National research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in study.

Human and Animal Rights This article does not contain any studies with animals performed by any of the authors.

References

1. Sloane PD, Baloh RW (1989) Persistent dizziness in geriatric patients. *J Am Geriatr Soc* 37(11):1031–1038
2. Chiarella G, Cassandra E (2010) Balance in elderly: overview and personal experience in paroxysmal positional vertigo. *BMC Geriatr* 10(suppl 1):A100
3. Dix MR, Hallpike CS (1952) The pathology, symptomatology and diagnosis of certain common disorders of the vestibular system. *Proc R Soc Med* 45(6):341–354

4. Riga M, Bibas A, Xenellis J, Korres S (2011) Inner ear disease and benign paroxysmal positional vertigo: a critical review of incidence, clinical characteristics, and management. *Int J Otolaryngol* 2011:709469. <https://doi.org/10.1155/2011/709469>
5. Guo X, Wang Q, Mei X et al (2015) benign paroxysmal positional vertigo associated with Meniere's disease: analysis of 30 cases. *J Clin Otorhinolaryngol Head Neck Surg* 29:925–927
6. Hanci D, Ulusoy S, Muluk NB, Cingi C (2015) Do viral infections have a role in benign paroxysmal positional vertigo? *B-ENT* 11(3):211–218
7. Liu H (2012) presentation and outcome of post-traumatic benign paroxysmal positional vertigo. *Acta Otolaryngol* 132:803–806
8. Gong N, Zhang X, Ge L, Xu D (2015) Clinical analysis of idiopathic sudden sensory hearing loss with vertigo. *J Clin Otorhinolaryngol Head Neck Surg* 29:1963–1965
9. Singh PP, Ghosh P, Kacker SK (1985) Presbyatonia. *Indian J Otolaryngol* 37(1):8–13
10. Abrol R, Nehru VI, Venkatramana Y (2001) Prevalence and etiology of vertigo in adult rural population. *Indian J Otolaryngol Head Neck Surg* 53(1):32–36
11. Schweigart G, Chien RD, Mergner T (2002) Neck proprioceptors compensate for age related deterioration of vestibular self-motion perception. *Exp Brain Res* 147:89–97
12. Chu CH et al (2015) Migraine is associated with an increased risk for benign paroxysmal positional vertigo: a nationwide population-based study. *J Headache Pain*. <https://doi.org/10.1189/s10194-015-0547-z>
13. Maarsingh OR, Dros J, Weert HC et al (2009) Development of diagnostic protocol for dizziness in elderly patients in general practice: a Delphi procedure. *BMC Fam Pract* 10:12
14. Kirtane MV (2009) From electronystagmography. In: Biswas A (ed) *Clinical audiovestibulo-metry for otologists and neurologists*, 3rd edn. Bhalani Publishing House, Mumbai, pp 109–147
15. Kirtane MV (1979) Standardization in Electronystagmography. *Indian J Otolaryngol* 31(4):126–131
16. Claussen CF (1972) Butterfly chart for caloric nystagmus evaluation. *Arch Otolaryngol* 96:371–375
17. Kacker SK (1981) Correlation of MVSP and frequency of nystagmus in diagnosis. *Indian J Otolaryngol* 30(2):49–51
18. Epley TM (1992) The Canalith repositioning procedure for treatment of Benign paroxysmal positional vertigo. *Otolaryngol Head Neck Surg* 107:395–404
19. Claussen CF, Kissingen B, Franz B (2006) Contemporary and practical neurootology. Special edition for Solvey Pharmaceuticals GmbH, Hans-Bockler-Allee 20, 30173 Hanover, Germany, pp 109–133
20. Selvakumar P, Balraj A, Kurien R et al (2012) Clinical and audio vestibular profile of Meniere's disease in a tertiary care centre in India. *Indian J Otolaryngol Head Neck Surg* 64(4):351–355
21. Deka RC, Bhatia R (1985) Clinical profile of cases of vertigo. *IJO* 37:144–146
22. Kirtane MV, Merchant SN, Ingle MV et al (1986) Vertebro-Basilar insufficiency as a cause of vertigo-myth or reality. *Indian J Otolaryngol* 38(1):18–20
23. Pipal SK, Soni S, Sharma S et al (2009) A Study of Incidence of Vertigo its Clinico Pathological profile and Etiology. *Indian J Otol* 15(3):29–36
24. Kim JS, Zee DS (2014) 2014 Clinical practice Benign paroxysmal positional vertigo. *N Engl J Med* 370:1138–1147
25. Jose P, Rupa V, Job A (1999) Successful management of Benign paroxysmal positional vertigo with Epley manoeuvre. *Indian J Otolaryngol Head Neck Surg* 52(1):49–53
26. Thakar A, Deka RC (2000) The particle repositioning maneuver for Benign paroxysmal positional vertigo. *Indian J Otolaryngol Head Neck Surg* 52(2):128–132

27. Mundra RK, Anand CS (1986) Study of ageing process on vestibular function. *Indian J Otolaryngol* 38(2):75–76
28. Lee NH, Ban JH, Lee KC, Kim SM (2010) Benign paroxysmal positional vertigo secondary to inner ear disease. *Otolaryngol Head Neck Surg* 143(3):413–417. <https://doi.org/10.1016/j.otohns.2010.06.905>
29. Huang MC, Chen S, Wang PC et al (2014) Automate virtual reality rehabilitation evaluation for chronic imbalance and vestibular dysfunction patients. In: *Advanced technologies, embedded and multimedia for human-centric computing lecture notes in electrical engineering* 260, Dordrecht, 1099–105. https://doi.org/10.1007/978-94-007-7262-5_125