Electronystagmography a Very Useful Diagnostic Tool in Cases of Vertigo

Sanjay Kumar Gupta¹ · Raj Kumar Mundra²

Received: 9 March 2015 / Accepted: 7 May 2015 / Published online: 17 May 2015
© Association of Otolaryngologists of India 2015

Abstract A significant number of patients seen in otorhinolaryngology have symptoms of vestibular dysfunction. Examination of vestibulo-ocular reflex has been and still is the principal method of evaluating vestibular functions. Electronystagmography (ENG) has been the gold standard to test the vestibular functions. The present study aims to evaluate the utility of ENG in diagnosing the etiology of vertigo. Total of 50 patients of either sex presenting with vertigo underwent ENG after a detailed history according to the proforma of questionnaire and routine ENT examination attending ENT OPD. In selected cases CT/MRI scan and other relevant investigations were done. Nystagmograph 2 + 1 channel machine was used to study the spontaneous nystagmus and bithermal caloric tests, parameter used for evaluation of ENG being central culmination frequency. The results were transferred on Claussan's Butterfly chart. In our study Peripheral lesion was observed in 29 cases, 19 cases had central lesion while 2 cases were mixed lesion. The data obtained was compared with those reported in other series. It was concluded that, supported by detailed history and neuro-otological examination ENG was found to be an essential tool for the diagnosis of vertigo whether central or peripheral origin along with identification of etiology of vertigo.

Keywords Electronystagmography (ENG) · Central lesion · Peripheral lesion · Vertigo

Introduction

There is a rise in the number of patients reporting to otorhinolaryngology and neurology services with signs and symptoms of vestibular dysfunction. *These patients often undergo CT scan and MRI of brain as initial investigation whereas, examination of vestibulo-ocular reflex has been and still is the principal method of evaluating vestibular functions.* This reflex has generally been studied by caloric test and observation of induced nystagmus by visual impression alone. Finer details of nystagmus like frequency, direction, and amplitude cannot be determined reliably by this method. Also, it is important to know the presence or absence of spontaneous nystagmus which is the only sign of vestibular examination. Nystagmus 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. The direction of nystagmus is designated by the direction of quick or fast component. ENG has been one of the most important objective means for evaluation of Vertigo. By ENG eye ball movement is recorded by recording the changes in the corneo retinal potential during nystagmus [1]. This method gives a documented record of spontaneous nystagmus with eyes close, gaze nystagmus, eye pursuit movement, position nystagmus and bithermal caloric nystagmus [2, 3]. The presence of nystagmus with eye open and its behavior changes with eye closure or in darkness is of special value in differentiating end organ lesion of inner ear from the central lesion. Thus helpful to evaluate the side of lesion and whether it's peripheral or a central

✉ Sanjay Kumar Gupta
dr.sanjaygupta27@gmail.com

¹ Department of ENT, Index Medical College Hospital & Research Centre, D-2, H. I. G. Colony, Behind Shopping Complex, A.B. Road, Indore 452010, Madhya Pradesh, India

² ENT Department, MGM Medical College & MY Hospital, Indore, Madhya Pradesh, India

lesion, also gives a clue whether lesion is recovering, static or progressive.

Maximum slow phase velocity is considered to be the most sensitive parameter for ENG evaluation but studies have compared the sensitivity and consistency of this parameter and concluded that due to manual calculation it involves risk of individual error. The culmination phase is the 3 adjacent 10 s interval of caloric response showing maximum number of beats. 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 [4]. The observations of ENG like spontaneous nystagmus and bithermal caloric test responses can be represented on a Butterfly Chart [2, 3]. This method of representing culmination frequency quantitatively can be easily interpreted and is comprehensive.

Materials and Methods

The study group was patients of either sex of all age groups attending the ENT OPD, from November 2008 to December 2009 presenting with vertigo for the first time. Detailed history was taken in all cases according to proposed proforma of vertigo clinic. A complete otorhinolaryngological and neurological examination was carried out in all the patients, presence of wax in the ear or perforation of ear drum were ruled out. Routine investigations included complete blood count, routine urine, fasting blood sugar, pure tone audiogram in cases with decreased hearing, X-ray cervical spines in patients complaining associated pain in neck and ENG was done in all the cases after withdrawing labyrinthine sedatives for 48 h prior to the test. Nystagmrite 2 + 1 channel machine by RMS was used for ENG.

ENG Recording

In a dark room Patient was made to lie supine on a couch with eyes closed and head end raised by 30 degrees above the horizontal, to bring the horizontal semi circular canal in vertical plane where they can be maximally stimulated. The skin surface of face was cleaned with water and six electrodes applied using adhesive tape and paste. Electrode resistance test was done to ensure proper connection of electrodes. Biocalibration was done by asking the patient to look at the lights on calibration bar alternately from right to left which is placed at foot end of the patient. After machine was calibrated, recording of ENG was done first for spontaneous nystagmus with eyes closed followed by Gaze nystagmus to 30° to right and left, pendular eye tracking test, optokinetic test and positional test in five head positions. Next irrigation catheters were fixed on sides along

with collecting trays and bithermal caloric tests were done using 20 cc syringes on right and left ear with water at 44 °C followed by right and left ear at 30 °C. An interval of 8 min was given after every caloric test. The ENG graph obtained was manually studied and the 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 [2].

Results

The various statistical results concluded from the master chart indicate that vertigo is more common above the age of 31 years and incidence drops again at the age of 60 years and above. It is worth noting that in the 21–30 years age group, females are more affected by vertigo though the overall male female ratio in study group is 68 and 32 % respectively. Pipal et al. [5] observed a male female ratio of 64–36 % respectively [5]. Various peripheral vestibular lesions accounted for 58 %, central lesions were 38 and 4 % were mixed lesions. Pipal et al. [5] observed 56 % peripheral lesion and 44 % central lesion in their study [5].

In present study 70 % patients presented with instability, 58 % had rotatory objective vertigo. Falling tendency in 36 %, black out in 20 %, rolling sensation in 18 %, lifting sensation in 6 and 2 % reported sinking sensation. It was also observed that many patients had two or more presenting complaints.

Gaze nystagmus was observed only in 9 out of 31 cases, positional nystagmus in 22 cases, all of peripheral type with latent period, fatigability and adaptation. Pendular eye tracking test was Type I or Type II in all 31 cases of the study group, all suggesting a peripheral lesion (Fig. 1).

Out of 19 test cases of central lesion, gaze nystagmus was positive in 16 cases, positional nystagmus in 18 and PETT was ataxic type in 15 cases (Fig. 2). Thus these parameters of ENG are good indicators of a central lesion.

The present study observed 24 patterns of ENG Butterfly Trinary code as compared with 68 codes observed by Claussen et al. (2006), out of which 23 patterns were found with the occurrence of more than 1 % and 45 patterns were having occurrence of rate of less than 1 % [6]. The small study group may explain the occurrence of only 24 patterns in this study (Table 1). Hazarika et al. [7] observed 21 patterns which is comparable to our present study [7]. The most common code was “OOOO” (22.00 %) which is comparative to study by Singh et al. [8] 32 % and Claussen et al. (2006) 43.673 %, explained this due to the content of students and other normal persons of the neuro-otological data bank [6, 8].

Fig. 1 Smooth PEST in peripheral lesion

Fig. 2 Irregular pattern of PEST in central lesion

Table 1 Distribution of cases according to Claussen's butterfly chart

Serial no.	Trinary code	No. of cases	Percentage
1	0000	11	22.0
2	0001	3	6.0
3	2020	2	4.0
4	0020	2	4.0
5	1011	1	2.0
6	0222	1	2.0
7	1010	4	8.0
8	0210	1	2.0
9	0010	4	8.0
10	1111	2	4.0
11	0111	2	4.0
12	1000	2	4.0
13	1100	2	4.0
14	1110	1	2.0
15	0011	2	4.0
16	0002	1	2.0
17	2222	2	4.0
18	0100	1	2.0
19	2002	1	2.0
20	0220	1	2.0
21	1001	1	2.0
22	0200	1	2.0
23	0101	1	2.0
24	0202	1	2.0
Total	24	50	100.0

Among the peripheral causes of vertigo were, unilateral canal paresis seven cases, bilateral canal paresis three cases, labyrinthitis four cases, vestibular neuronitis four

cases, Meniere's disease five cases Benign paroxysmal positional vertigo five cases and one case each of streptomycin toxicity, Diabetes mellitus and cervical rib. The central lesion group comprised of vertebro-basilar insufficiency five cases; all of them showed reduced blood flow in vertebral arteries and basilar artery in magnetic resonance imaging with angiography of brain and neck, brain stem lesion three cases, epilepsy two cases, acoustic neuroma two cases, supratentorial SOL one case and six cases were of undetermined central lesion.

Discussion

In most of the previous studies peripheral vertigo is more common than central vertigo and the CT and MRI of brain were normal, hence ENG plays a vital role in diagnosis and management of these patients. Kirtane [3] summarized that the incidence of central lesion is almost as high as peripheral lesion in causation of vertigo [3]. Bhatia and Deka [9] observed 44.5 % peripheral, 22.5 % central and 26.7 % unclassified [9]. Gopal [10] observed 100 % peripheral lesions [10], Majumdar et al. (2002) 89.5 % peripheral and 10.5 % central causes of vertigo [11].

In the present study of 19 cases of central lesion 63.15 % had vertigo. Singh [8] found the incidence of inner ear lesion as 77.5 %. The incidence in the present study was in between the two series due to different criterion and the selection of cases. All the cases in the central lesion group exhibited failure of optic fixation suppression of nystagmus (Fig. 3), 84.2 % of cases showed gaze nystagmus and positional nystagmus was observed in 95 % cases while pendular eye tracking test was ataxic type in 80 %

Fig. 3 No change in amplitude and frequency of nystagmus on eye opening in central lesion

Fig. 4 Suppression of frequency and amplitude of nystagmus in peripheral lesion

cases. These patients were subjected to CT/MRI scan, three cases had ischemia at brain stem region, two cases that Acoustic neuroma, one patient had supra tentorial space occupying lesion. Electro encephalography was done in two cases and epilepsy was confirmed.

Out of 50 cases, 31 cases were of peripheral vestibular lesion, among these seven cases were bilateral peripheral lesion and 24 cases had unilateral peripheral lesion. Spontaneous nystagmus was present in 20 cases which decreased in amplitude and frequency on opening the eyes in dark (Fig. 4). In unilateral peripheral lesion 85.7 % of cases had spontaneous nystagmus beating to the healthy side with hypo response on the ipsilateral ear on irrigation with 44° water. In present study five patients with Benign paroxysmal positional vertigo had normal caloric responses but positional tests were abnormal. In bilateral peripheral lesion 33.33 % cases had spontaneous nystagmus while 66.66 % did not show nystagmus, 33.33 % showed hypo response on both right and left 44° irrigation, 33.33 % had hypo response with all irrigations except left 30° cold

irrigation, while 33.33 % had hypo response on all four irrigations. Meniere's disease was diagnosed in five cases, 80 % showed ipsilateral hypo response with cold (30°) irrigation (Fig. 5) and 20 % had normal response, and probably patient was of early Meniere's or in remission. Claussen et al. stated that ipsilateral cold hypo response and rest of caloric responses in normal limits is thought to be suggestive of true Meniere's [12].

Conclusion

From the present study it has been found that ENG is a vital investigation for diagnosis of vertigo and its role comes much before an MRI or CT scan of brain as ENG gives an idea of the physiology of the vestibular system and its neurological connections where as latter give information regarding the anatomy of the brain and finer details of nystagmus and its behavior cannot be studied by mere visual observation.

Fig. 5 Typical butterfly chart in Meniere's disease right side

It is concluded that peripheral vertigo is more common than central cause. Incidence of Vertigo is maximum between fourth and sixth decade of life with a male predominance. Vestibular end organ lesions have a definite pattern of spontaneous nystagmus; in peripheral lesions pendular eye tracking is Type I or Type II. Bithermal caloric test when plotted on Claussen's butterfly chart reflect definitive and comprehensive patterns. However in central lesions ataxic *Pendular eye tracking test is a good indicator for further investigations like CT/MRI scan or a neurological evaluation.* More over apart from the diagnosis, it's an important research tool for vertigo, has an important role to study the prognosis of disease and its medico legal aspects make it an indispensable tool. Further, performing an ENG has a psychological effect on the patient with documentary evidence regarding his disease which helps him regain his confidence and earns cooperation during management.

References

1. Biswas A (2009) Clinical audiovestibulo-metry for otologists and neurologists. In: Kirtane MV (ed) *Electronystagmography*, 3rd edn. Bhalani Publishing house, Mumbai, pp 109–147
2. Claussen CF (1972) Butterfly chart for caloric nystagmus evaluation. *Arch Otolaryngol* 96:371–375
3. Kirtane MV (1979) Standardization in electronystagmography. *Indian J Otolaryngol* 31(4):126–131
4. Mundra RK, Anand CS (1986) Study of ageing process on vestibular function. *Indian J Otolaryngol* 38(2):75–76
5. Pipal SK, Soni S, Sharma S, Asif SK (2009) A study of incidence of vertigo its clinico pathological profile and etiology. *Indian J Otol* 15:29–36
6. Contemporary & Practical Neurotology (2006) In: Claussen CF, Kissinger B, Franz B Special edition for solvey pharmaceuticals GmbH, Hans-Bockler-Allee 20, 30173 Hanover, pp 109–133
7. Hazarika P, Singh R, Agrawal D, Nayak DR, Balakrishnan R (2008) The role of electronystagmography in vertiginous patients. *Indian J Otol* 14:10–14
8. Singh BK (1987) Interpretation of ENG by Claussen's butterfly chart. *Indian J Otolaryngol* 39(4):145–149
9. Bhatia R, Deka RC (1985) Clinical profile of clinical profile of cases with vertigo. *Indian J Otolaryngol* 3(4):144–146
10. Gopal GS (1991) Peripheral vertigo—an assessment. *Indian J Otolaryngol* 43(3):161–162
11. Majumdar et al (2002) A study of peripheral vertigo in a Kolkata based hospital. *Indian J Otolaryngol Head Neck Surg* 54(2):101–104
12. Claussen CF, Desa JV (1979) Text book of study of human equilibrium by ENG and allied tests. Popular Prakashan, Pune