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Original Research Article

Electronystagmographic analysis of peripheral vertigo

Abinayaah Suresh[1]*, Gitanjali Narendran[2]

Department of ENT, Sri Muthukumaran Medical College Hospital and Research Institute, Tamil Nadu, India

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***Correspondence:**
Dr. Abinayaah Suresh,
E-mail: abin004doc@gmail.com

ABSTRACT

Background: Examination of the vestibulo-ocular reflex is still the investigation of choice for evaluating the vestibular function to rule out peripheral causes. Aim and objectives were to compare the electronystagmographic changes of all peripheral forms of vertigo and to highlight its significance in the diagnosis and management of the same.
Methods: This is a prospective study done after obtaining ethical committee approval in a total of 100 patients attending the ENT OPD at Sri Muthukumaran Medical College Hospital & Research Institute with chief complaints of vertigo. Patients diagnosed with chronic suppurative otitis media, hypertensive patients, h/o seizures, recent cardiac illness or patients on cardiac investigations, psychotic disorders, documented CNS lesions, cervical spondylitis, h/o recent eye/ ear surgery are excluded from this study. ENG analysis includes occulomotor testing, positional testing and caloric stimulation. Evaluation of gait and balance is done followed by maneuver induced vertigo testing (dix hallpike and fistula test) along with PTA. Statistical analysis was done using independent sample t test and chi square test to check the hypothesis using statistical package for social studies SPSS version 17.
Results: The observations of ENG like spontaneous nystagmus and bi-thermal caloric test responses are represented on a claussens butterfly chart and the corresponding bar codes were obtained. The inferences for different forms of vertigo were studied.
Conclusions: ENG is now an accepted routine and basic investigation in the management of all patients suffering from equilibrium disorders. Management consists of diagnosing the underlying pathology and treatment of the same.

Keywords: Electronystagmography, Vestibulo-ocular reflex, Peripheral vertigo, Nystagmus, Caloric testing, Claussen's butterfly chart

INTRODUCTION

Dizziness and vertigo are very common syndromes in daily practice. Peripheral vertigo is more common than central causes and is caused by any disturbance in the vestibular system, the semicircular canals, or the vestibulo-cochlear nerve and they account for about 85% of all cases of vertigo. The causes are many including benign paroxysmal positional pertigo (most common) followed by meniere's, vestibular neuronitis, labyrinthitis, acoustic neuroma, ototoxicity, perilymphatic fistula and in rare conditions like cogan syndrome. It is important to remember that vertigo is a symptom and not a diagnosis. Also, it is episodic and acute in peripheral causes.

Nystagmus is an important sign in the evaluation of the vestibular system, characterized by involuntary, rhythmical, oscillatory movement of the eyes. In vestibular nystagmus, the direction of nystagmus is given by the direction of the fast component and is fatigable.

The vestibulo ocular reflex (VOR) is the reflex by which the direction of the eyes remains constant when the head is moved. This VOR reflex involves a three-neuron arc consisting of the oculomotor nuclei, vestibular nuclei and

vestibular ganglion sometimes referred to as Scarpa's ganglia. The pathways that generate the reflex are extremely complex in nature. It is the VOR that keeps us steady and balanced even when our eyes and head are continuously moving when we perform most actions and when it is impaired it causes difficulty in maintaining balance and nausea.[15]

Electronystagmography (coined by Meyers in 1929) is a method of detecting and recording of nystagmus which is spontaneous or induced by caloric, positional, rotational or optokinetic stimulus. It is a vital investigation for the evaluation of vertigo where the eyeball movement is recorded with the help of the changes in the corneo retinal potential.[1] It also permits to keep a permanent record of the nystagmus.[16,17]

ENG is now an accepted routine and basic investigation in the management of all patients suffering from vertigo and equilibrium disorders. Even after the tremendous development of various imaging techniques like CT and MRI , ENG is still the investigation of choice in balance disorders as they are caused by subtle functional disorders like microscopic degenerative lesions or metabolic disorders like neurotransmitter deficiencies which are invisible to imaging modalities and they only provide information about the structural abnormalities of the vestibular system such as tumours, bleeding, haemorrhage etc which rarely cause balance disorders.[1,2]

Treatment is usually to identify the underlying process. Apart from maneuvers and medical therapy vestibular rehabilitation therapy is of some relief to patients.

The prognosis of peripheral vertigo is quite favourable once the exact etiology is identified.[3]

METHODS

This is a prospective study done after obtaining ethical committee approval in a total of 100 patients attending the ENT OPD at Sri Muthukumaran Medical College Hospital & Research Institute with chief complaints of vertigo. Patients diagnosed with chronic suppurative otitis media, patients with h/o hypertension, h/o seizures, recent cardiac illness, psychotic/neurotic disorders, documented CNS lesions, cervical spondylitis, h/o eye surgery (in the previous 3 months) and ear surgery (in the previous 6 months) are excluded from this study.

Certain precautions and advice prior to testing are mandatory. Patients on sedatives and anti-vertiginous drugs are asked to stop them 24 to 72 hours prior to testing and any other medications taken should be clearly noted on the test results. Patients should limit their food intake 2 and 1/2 hours prior to examination and should not have consumed alcohol at least for the past 72 hours. Finally, patients should always have an accompanying person and proper means of transportation to his/her residence should have been arranged.

A routine otoscopic examination is done to check if both the tympanic membranes are intact followed by PTA and the patient is clearly explained about the procedure and that any episode of giddiness is normal.

ENG analysis essentially consists of three components - oculomotor testing, positional testing and caloric stimulation.

Prior to occulomotor examination the range of movements of the eye and cervical range of movements are checked. Occulomotor testing consists of spontaneous nystagmus, gaze holding nystagmus, skew deviation, vergence, decreased vestibulo ocular reflex (head thrust test & dynamic visual acuity) and visual tracking (smooth pursuit, saccadic eye movement & VOR cancellation).

Evaluation of gait and balance is done followed by maneuver induced vertigo testing (Dix Hallpike & fistula test).

The results were analyzed using statistical package for social sciences (SPSS) version 17 and independent sample t test and chi squared test was used appropriately to check the hypothesis.

P value less than 0.05 was considered as statistically significant.

Testing using electronystagmography

Skin preparation and electrode attachment

Here, recording is switched on before connecting it to the patient.

Using mildly abrasive gel, the skin is rubbed carefully prior to electrode placement (forehead, near the right and left exterior canthi).

Method of electrode placement

One electrode is placed in the center of the forehead, two electrodes are placed one above the eyebrow (U) and the other one below the eye (D), two electrodes are placed one on each side of the eye (R&L), U and D for recording vertical movements, L and R for horizontal movements, centre electrode connects to the ground, retina to be charged negatively against the cornea, when the patient is connected and disconnected from the equipment, the ground lead should be connected first and disconnected last.

Fitzgerald hallpike bithermal caloric testing

The patient should lie supine with head tilted 30 degrees forward so that the horizontal canal is in vertical position.

The order of irrigation will be right warm, left warm, right cold and left cold. The temperature for warm and

cold irrigations are 30 and 44-degree celsius respectively and there should be a gap of 4-6 minutes between each irrigation. The time taken from the start of irrigation till the end point of nystagmus is noted and charted on a calorigram. In the absence of nystagmus, irrigation is repeated with a temperature of 20-degree celsius for 4 minutes and looked again for nystagmus in the absence of which it is labeled as a 'dead labyrinth'.

The caloric response should be measured in terms of either maximum slow phase velocity (SPV) of the nystagmus in degrees per second or the duration of nystagmus in seconds.

Canal paresis (%) is calculated by Jongkees et al 1962.[10]

$$\frac{(RW + RC) - (LW + LC) \times 100}{RW + RC + LW + LC}$$

Directional preponderance is given by

$$\frac{(RW + LC) - (LW + RC) \times 100}{RW + RC + LW + LC}$$

(RW- warm stimulus in the right ear; RC- cool stimulus in the right ear; LW- warm stimulus in the left ear; LC- cool stimulus in the left ear).

RESULTS

Out of the 100 patients 36 patients had normal ENG and 64 patients had changes in the caloric testing. 38 patients were male and 62 were females.

Total 7 patients were below 30 years of age, 35 patients between 31-50, 45 patients between 51-70 and 13 patients between 71-90 years of age.

Total 42 patients had involvement of the right ear and 46 had left. Bilateral involvement was seen in 12 patients.

Directional preponderance was observed in 64 patients (28 males and 36 females) and was absent in the remaining 36 (9 males and 27 females). Pure tone audiometry was normal in 58 patients whereas 42 patients had varying degrees of sensorineural hearing loss.

This study included a total of 51 patients with benign paroxysmal positional vertigo (BPPV), 21 with Meniere's, 6 cases of labyrinthitis, 6 with vestibular neuronitis, 10 cases of ototoxicity and 6 other peripheral forms of vertigo. The observations of ENG like spontaneous nystagmus and bi-thermal caloric test responses are represented on a claussens butterfly chart.

Butterfly charts with bar codes

The various inferences obtained through caloric testing are recorded using ENG and represented on a Claussen's butterfly chart as shown in (Figures 1-5).

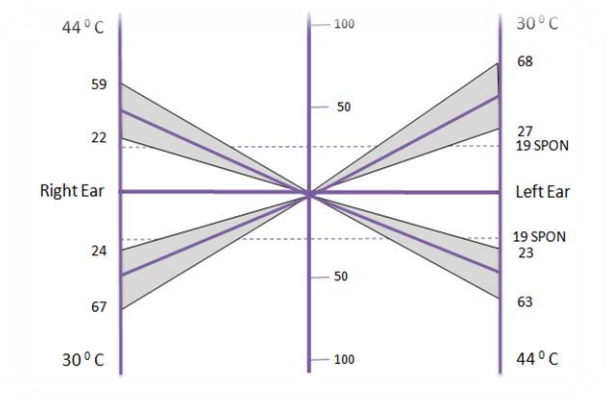

Figure 1: Normal ENG.

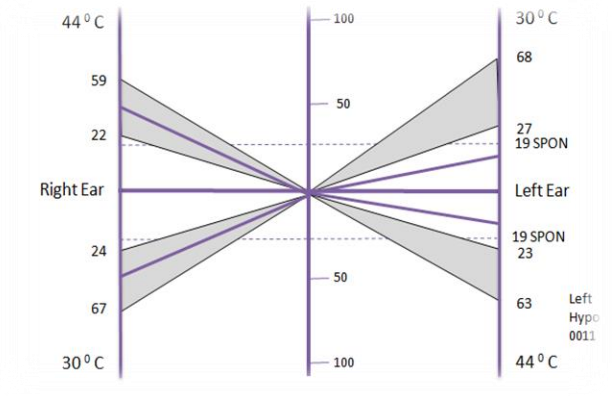

Figure 2: Left hypoactivity.

BAR CODE 0000 (all four quadrants are within normal limits) (Figure 1) BAR CODE 0011 (both the right warm and cold-water stimulation had a normal response where as in the left side, there was a diminished response to both warm and cold caloric stimulation) e.g. Meniere's - Left ear, i.e. a left peripheral vestibular system lesion (Figure 2). BAR CODE 1111 (all four quadrants show a diminished response to bithermal caloric testing) eg. vestibular ototoxicity) (Figure 3).

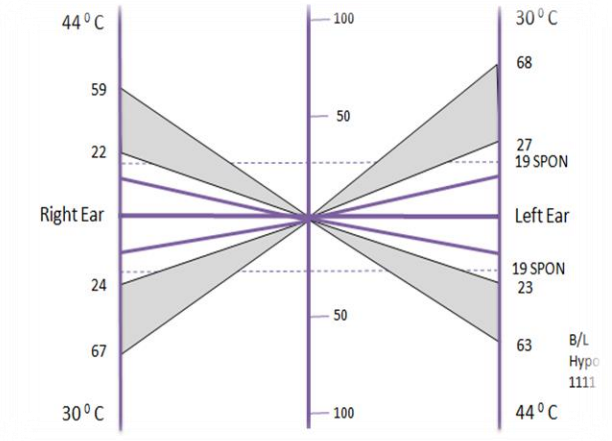

Figure 3: Bilateral hypoactivity.

BAR CODE 2000 (right warm caloric stimulation showed an increased response whereas right cold and left ear stimulations were within normal limits) e g. irritable labyrinth (Figure 4).

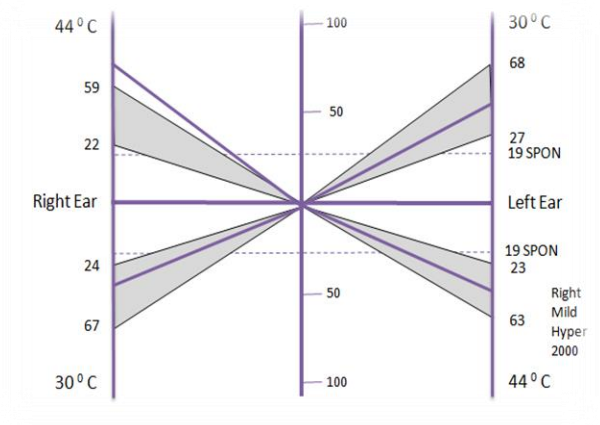

Figure 4: Right mild hypoactivity.

BAR CODE 1000 (right warm response is diminished and all others are within normal limits) eg: vestibular hypoactivity, abnormal canal paresis etc.

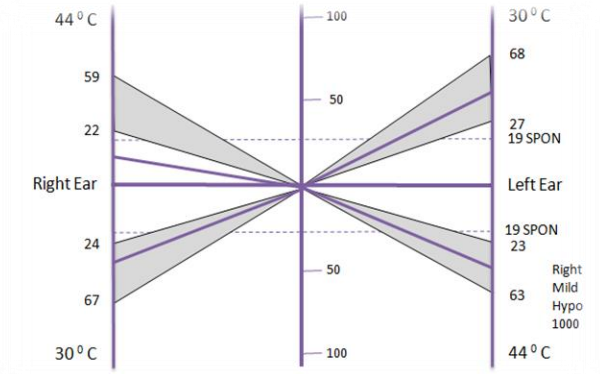

Figure 5: Right mild hyperactivity.

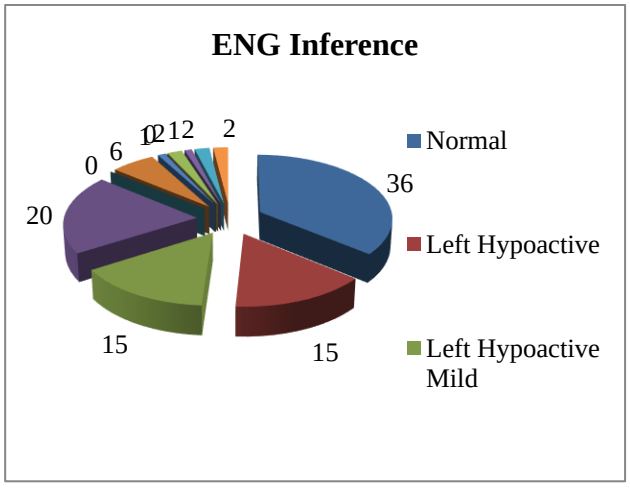

Figure 6: ENG inference.

ENG inference shows in (Figure 6). Inference of ENG among 100 patients show in (Table 1).

Table 1: inference of ENG among 100 patients.

ENG Inference	Number	%
Normal	36	36.00
Left Hypoactive	15	15.00
Left Hypoactive Mild	15	15.00
Right Hypoactive	20	20.00
Right Hypoactive Mild	0	0.00
Bilateral Hyperactive	6	6.00
Bilateral Hypoactive	1	1.00
Bilateral Hyperactive	0	0.00
Bilateral Hypoactive (Cold)	2	2.00
B/L; L>R; hypoactive	1	1.00
B/L; R>L Hypoactive	2	2.00
Right Hyperactive Mild	2	2.00
Total	100	100

Normal (all quadrants are within normal limits). Left hypoactive (both warm and cold caloric responses on the left side is diminished). Left mild hypoactive (warm caloric response on the left is normal where as cold caloric response is diminished). Right hypoactive (both warm and cold caloric responses on the right side is diminished). Right mild hypoactive (warm caloric response on the right is normal where as cold caloric response is diminished).

DISCUSSION

Many studies show that vertigo is more common above the age of 31 years and the incidence drops again after the age of 60 and above.[3] In our study also 69% of patients were between 31-60 years of age and the remaining 31% were below 30 or above 60 years or age.

An abnormal ENG in cases of BPPV according to Korres et al. series of 2004, was 42.8 % where, out of 168 patients, 72 had abnormal ENG findings (42.8%) and 96 had normal findings (57.2 %) whereas in this study out of 51 cases diagnosed with BPPV, 32 cases had normal findings (62.7%).[5]

Hence ENG changes are present in BPPV but not always which is similar to previous studies. Also, in BPPV the vertical component of nystagmus can be recorded whereas the torsional component of nystagmus which could be clinically seen could not be recorded. These findings are also similar to Korres et al. series of 2004 as well as Ko et al series of 2013.[5,6]

In Meniere's hypoactivity of the affected side as well as directional preponderance was present similar to a study by Dobie, et al. series of 1982.[7]

More recently many studies have recently pointed out that there is a pattern in Meniere's where the caloric

testing is abnormal where as VHIT is normal due to hydrops. Also, the extent of hydrops correlates with the extent of caloric weakness with normal VHIT tests.[7,12,14]

Choi et al of 2007 also pointed out the same discrepency. In our study also caloric tests showed better sensitivity compared to VHIT especially in patients with chronic complaints.[14]

Our results suggest that unilateral vestibular hypo activity is the cornerstone in the diagnosis of peripheral vestibular lesions as stated in many other researches. However, it has to be evaluated with other data in order to find out the exact location of the lesion.

Cold irrigations produce a more drastic response in the measured show- phase nystagmus and is thus more specific in ruling out a peripheral lesion.

Directional preponderance has limited value according to this study. It is present only in chronic conditions where it is transient and benign such as BPPV and Meniere's similar to Halmagayi et al series of 2000.[11]

CONCLUSION

Dizziness and vertigo are very common syndromes in daily practice. Peripheral vertigo is more common than central causes with a maximum incidence between the 4rth to the 6th decade of life with a male predominance. Examination of the vestibulo-ocular reflex has been and still is the principal method of evaluating the vestibular function. ENG analysis becomes an important tool here that aids in evaluation.

Apart from this ENG is noninvasive and inexpensive and gives a permanent record to compare in future. However, ENG alone cannot be a diagnostic or confirmatory test but has a key role in the prognosis.

The ability to stimulate each labyrinth separately is the main advantage of ENG which in turn helps us to know about the functioning of the left versus the right side separately.

There are 3 primary goals of the balance system- to maintain center of gravity, provide accurate proprioception and to control the eye movements in order to maintain a clear visual image during motion. With the help of ENG the ability of the balance system to achieve these goals can be evaluated.

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