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Prevalence of Vertigo in Different Age Groups and Common Butterfly Patterns in Electronystagmography in Central India: A Retrospective Study

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Abstract: *A significant number of patients of all age groups are seen in Otorhinolaryngology having symptoms of vertigo. Further due to automobile accidents and changing life style pattern there is constant increase in the patients presenting with dizziness and imbalance at early age. This retrospective study was undertaken to study the prevalence of vertigo in different age groups, male and female ratio and the various Electronystagmography (ENG) parameters along with the identification of common butterfly patterns. The study group comprised of 300 patients from the data base presenting with dizziness, imbalance, rotational vertigo, unsteadiness as the chief complaint at ENT centre and vertigo clinic from January 2010 to December 2014. Patients with Otitis externa, acute Otitis media, Suppurative Otitis media and history of ear surgery along with vertigo were excluded. Data obtained from the neuro-otology proforma of these patients and the ENG findings were tabulated in the master chart and the observations and results obtained and transferred to Claussen's butterfly chart. Observations were analyzed and compared with previous studies. The study exhibited the age of patients with vertigo ranged from 7 years to 88 years. Highest incidence was seen in third, fourth, fifth and sixth decade of life, out of 300 cases 57% were male and 43% were female. Normal butterfly pattern was observed in 13.666% and pathological in 86.334%. This study observed 31 butterfly patterns out of 81 possible butterfly patterns. Bilateral peripheral receptor inhibition occurred in 43.331 % with 6 different patterns. Unilateral peripheral receptor inhibition appeared as 4 patterns summing up to18.332%. Inhibition of peripheral cold response exhibiting irritative receptor state observed as in Meniere's disease in 12.665% demonstrating 4 butterfly patterns. The butterfly patterns observed as central nystagmus inhibition were 1.666% with 2 patterns and central nystagmus disinhibition or hyper response were 6.664% with 7 patterns adding on to 8.330%. However 3.664% cases with 7 patterns did not fall into a disease pattern.*

Keywords: *Age groups, Butterfly patterns, Electronystagmography, Vertigo*.

I. Introduction

Vertigo in today's perspective is more often due to peripheral vestibular disorders. Patients with dizziness 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. 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 [1] 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 lesion, also gives a clue whether lesion is recovering, static or progressive [2]. 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, measurement of culmination frequency which is another parameter used widely and less likely to cause manual calculation error with ease of measurement has been accepted as an equally sensitive and accurate parameter for ENG. The culmination phase is the 3 adjacent 10 second 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 [3].

In this era of evidence based medicine role of ENG, Audiometry, Electro cochleo-graphy, Vestibular evoked myogenic potential, CT scan and MRI with angiography of brain along with other relevant investigations play a major role in diagnosis of vertigo [4]. Clausen 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

[5]. ENG enables to measure and document various parameters like spontaneous nystagmus, gaze nystagmus, optokinetic nystagmus positional nystagmus and bithermal caloric induced nystagmus and helps in quantitative interpretation of caloric test data by transferring the same on Claussen's butterfly chart. Apart from identifying the side of lesion, ENG gives an insight into the vestibular reflex arc and its connections with brain and facilitate the testing of integrity of function of brainstem [6]. Today ENG is a standard tool in the battery of diagnostic test for Vertigo.

II. Material and Methods

The present retrospective study was carried out between November 2010 to December 2014 at ENT center and vertigo clinic. Study group was patients of either sex of all age groups ranging from 7 years to 88 years, presenting with vertigo for the first time. Total of 300 patients were evaluated from the database presenting with vertigo as the chief complaint. Exclusion criteria were patients with Otitis externa, Suppurative Otitis media and history of ear surgery.

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 CT scan MRI angiography were done in few cases showing features of central lesion. ENG was done in all the cases after withdrawing labyrinthine sedatives for 72 hours prior to the test. Nystagmorite 2+1 channel machine by RMS was used for ENG.

ENG recording was done in a dark room, with patient in supine position 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 patent 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 degrees 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 degree Celsius followed by right and left ear at 30 degree Celsius. An interval of 8 minutes was given after every caloric test. The ENG graph obtained was manually 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. 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 [6]

III. Results

The present retrospective study is a statistical compilation of 300 cases of vertigo, study of prevalence in different age groups, the sex ratio and occurrence of common butterfly patterns on Electronystagmography. The observations and results are as follows.

In this retrospective study of 300 cases, Table 1 summarizes the age distribution and male female ratio of vertigo. It shows 171 male (57%) as compared to 129 female (43%), giving a male: female ratio of 1.32: 1. 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 [2]. Yet another study of 1455 patients by Kirtane et al 1986 observed a male: female ratio of 2.2: 1 where age ranged from 21 to 75 years [7]. Gopal 1991 observed 4: 1 male: female ratio with highest incidence in third and fourth decade followed by fifth and second decade of life in a study of 80 patients [8]. Burman et al 2002 in a study of 95cases reported male: female ratio of 5:1 with 80% of cases in the age group between 21 to 50 years [9]. Pipal et al 2009 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 [10]. The present study indicates an increase in the incidence of vertigo in females.

Table 2 shows the coding of the two right ear responses marked in the abscissa in the order of right warm followed by right cold. The two responses of left ear are marked in ordinate in the order of left warm followed by left cold. The study sample of 300 butterfly calorigrams has been evaluated according to their trinary configuration. The occurrence of normal butterfly with code "0000" is 13.666% (Fig.1) and is lower than the other studies. The study shows that normal pattern occurs in 13.666% and pathology with abnormal pattern 86.334%.

This study also demonstrates that out of 81 possible butterfly patterns, 31 butterfly patterns have been observed. 10 patterns have been observed with occurrence of less than 1%. Strikingly 50 patterns have not been observed in this sample. Out of observed 31 butterfly patterns in this study bilateral peripheral receptor inhibition occurred as "1010"= 6.000%, "1011"= 6.666%, "1101"= 7.333%, "0111"= 4.666%, "1110"= 2.333%, "1111" =16.333%. These 6 patterns sum up to 43.331%, demonstrating the most common pattern in this study (Fig. 2A, 2B, 2C, 2D, 2E, 2F).

Unilateral peripheral receptor inhibition findings are shown with following patterns in Table 2: "1000" = 5.666%, "1100" = 3.000%, "0010" = 6.666%, "0011" = 3.000%, These 4 patterns of peripheral inhibition add on to 18.332% occurring as the second most common butterfly pattern in this study (Fig. 3A, 3B, 3C, 3D). Table 2 exhibits inhibition of peripheral cold response or irritative receptor state observed as following patterns "0100" = 3.333%, "0001" = 2.333%, "0101"= 5.666%, "2100"= 1.333%,. These 4 patterns add on to 12.665% classically seen in Meniere's disease (Fig. 4A, 4B, 4C, 4D) [6].

Central directional nystagmus inhibition or inhibitory directional preponderance response occurred in this study as shown in Table as: "0110" = 0.666%, "1001" = 1.000% summing up to 1.666% indication a central cause of vertigo (Fig. 5A, 5B).

In this study central pathology or central nystagmus disinhibition exhibited as hyper response occurred as shown in Table 2: "0200" = 1.333%, "2000"= 1.333%, "0002" = 1.333%. "0020"= 0.333%, "2202"= 0.333%, "2012"= 0.333%, "2020"= 1.666%, these 7 patterns indicate central pathology and add on to 6.664% (Fig. 6A, 6B, 6C, 6D, 6E, 6F, 6G). In this study as shown in Table 2: 3.664% cases with 7 patterns do not fall into a disease pattern.

This study demonstrated 10 butterfly patterns appearing less than 1%, indicating that, they represent pathology yet to be identified. Unilateral peripheral inhibition with 4 patterns was seen in 18.332%, Bilateral peripheral inhibition was observed as 6 patterns in 43.331%, Butterfly patterns exhibiting irritative state was 12.665% as 4 patterns. A total of 74.328% contributing to 14 patterns suggested a peripheral cause of Vertigo.

IV. Discussion

The present study indicates an increase in the incidence of vertigo in females, there is an increase in the range of age of occurrence of vertigo which is 7 years to 88years. However the peak of occurrence is still highest in third decade 86 cases, fourth decade 70 cases, fifth decade 57, followed by 34 in second decade and 33 in sixth decade, 8 cases between the age of 11-20, with only 5 cases each in seventh and eighth decade and 2 cases below 10 years of age out of 300 cases. Increase in the number in younger age group may be due to increased awareness about disease and better availability of various investigations to diagnose vertigo. The rise in number of cases in geriatric age group may be attributed to increase in life expectancy and observation of Mundra et al 1986 that there is a hypo function of vestibule with increasing age [3].

This study exhibited 31 butterfly patterns. Ten butterfly patterns occurred less than 1%, indicating that these patterns are unstable and tend to fall into a group of more stable pattern. Unilateral peripheral inhibition was seen 4 butterfly patterns adding to 18.332%, Bilateral peripheral inhibition was observed in 43.331%, occurring as 6 patterns. The high incidence of bilateral lesion may be explained as the first episode of vertigo causing a unilateral peripheral vertigo which recovered in 3-4 weeks time goes unnoticed and is forgotten. The patient is able to maintain balance by phenomenon of central compensation [4]. 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 weakness. In Benign paroxysmal positional vertigo the butterfly chart is normal with code "0000", however there is evidence of position nystagmus in more than three head positions of positional test in ENG, this group was observed as 13.666%.

The butterfly patterns observed as central nystagmus inhibition were 1.666% and central nystagmus disinhibition or hyper response were 6.664% adding on to 8.330%.

Singh et al 1987 studied 25 patients of vertigo and observed 12 butterfly patterns [11]. Claussen et al 2006 studied 10335 patients and normal pattern with code "0000" was seen in 31.27% and abnormal pattern was reported in 68.73%. In another group of 7025 patients studied by Claussen et al, only 23 patterns were seen with occurrence of more than 1%, 13 patterns were not seen at all and 45 patterns had occurrence of less than 1% [5]. Hazarika et al 2008 studied 85 cases of vertigo and reported 21 butterfly patterns with code "0000" in 22.35% cases [12]. Naik et al 2010 studied 426 patients of whiplash injury with vertigo and observed 11 butterfly patterns, the same study reported normal butterfly with code "0000" in 33.5% [13].

Considering other studies with larger sample size demonstrating occurrence of 45 butterfly patterns with occurrence of less than 1% and non appearance of 13 butterfly patterns at all, it is speculated that these patterns are unstable and tend to fall into a group of more stable pattern. Moreover these patterns may be very rare and as the sample size of this study was small these patterns may be observed in much larger study sample, as these patterns are rare and occur in diseases which were not observed within this sample.

V. Figures and Tables

Table 1: Age wise male –female ratio of patients with vertigo

Age groups in years	Total	Male	Female
0-10	2	2	0
11-20	8	5	3
21 -30	34	23	11
31 -40	86	49	37
41 -50	70	43	27
51 -60	57	27	30
61 -70	33	17	16
71- 80	5	2	3
81- 90	5	3	2
TOTAL	300	171	129
Percentage	100 %	57%	43%

Table 2: Graphic butterfly conversion into Trinary digital codes. The sample of 300 butterfly calorigrams is taken from the present study. The occurrence of various Trinary code (300 cases = 100%) are displayed in the table as numbers and percentage among possible 81 codes [5]

Right Ear	00	01	02	10	11	12	20	21	22
Left Ear									
00	13.666	3.333	1.333	5.666	3.000	0.333	1.333	1.333	
01	2.333	5.666		1.000	7.333				
02	1.333								0.333
10	6.666	0.666		6.000	2.333				
11	3.000	4.666		6.666	16.333		0.666	0.666	
12	1.000						0.333		
20	0.333				0.333		1.666		
21					0.333		0.333		
22									

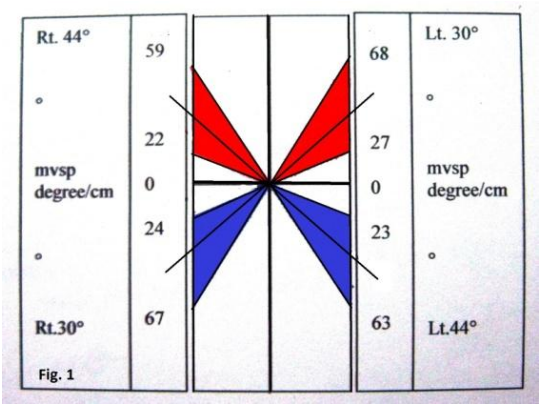

Fig. 1 Normal butterfly pattern Trinary code "0000"

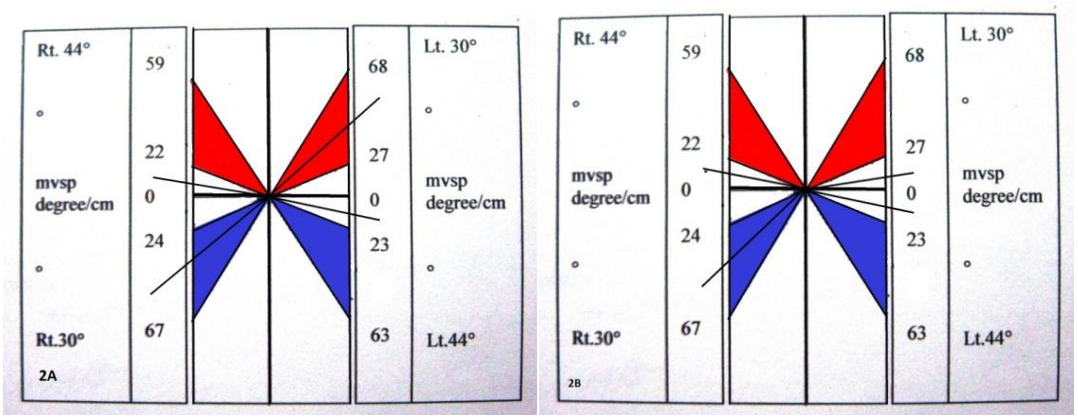

Fig. 2A, 2B Bilateral peripheral receptor inhibition, Trinary codes "1010", "1011", respectively

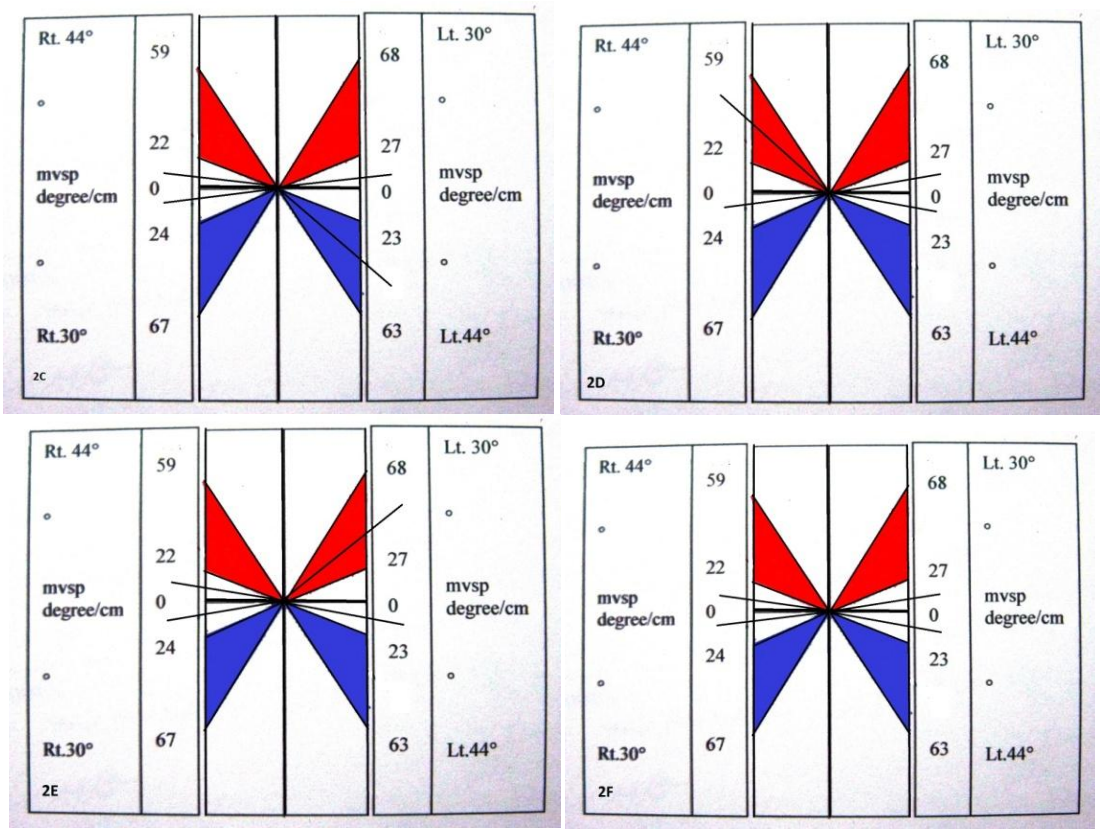

Fig. 2C, 2D, 2E, 2F Bilateral peripheral receptor inhibition, Trinary codes "1101", "0111", "1110", "1111" respectively

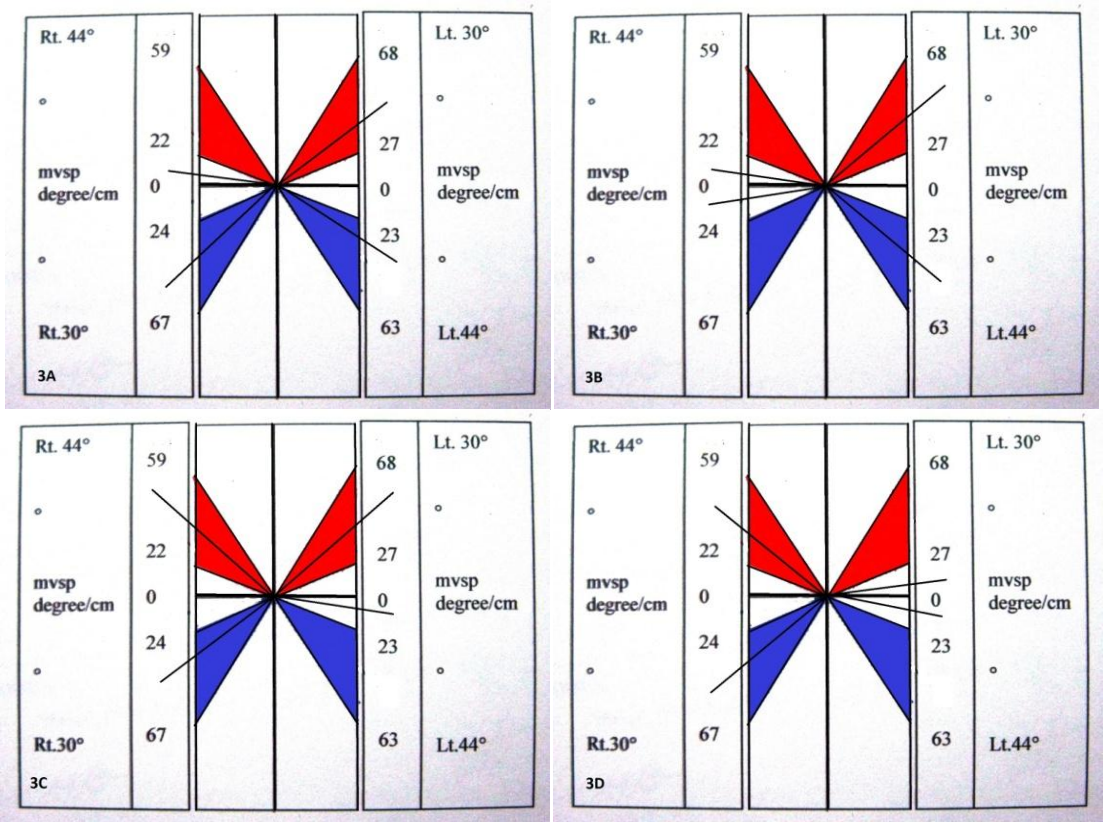

Fig. 3A, 3B, 3C, 3D Unilateral receptor inhibition Trinary codes "1000", "1100", "0010", "0011" respectively

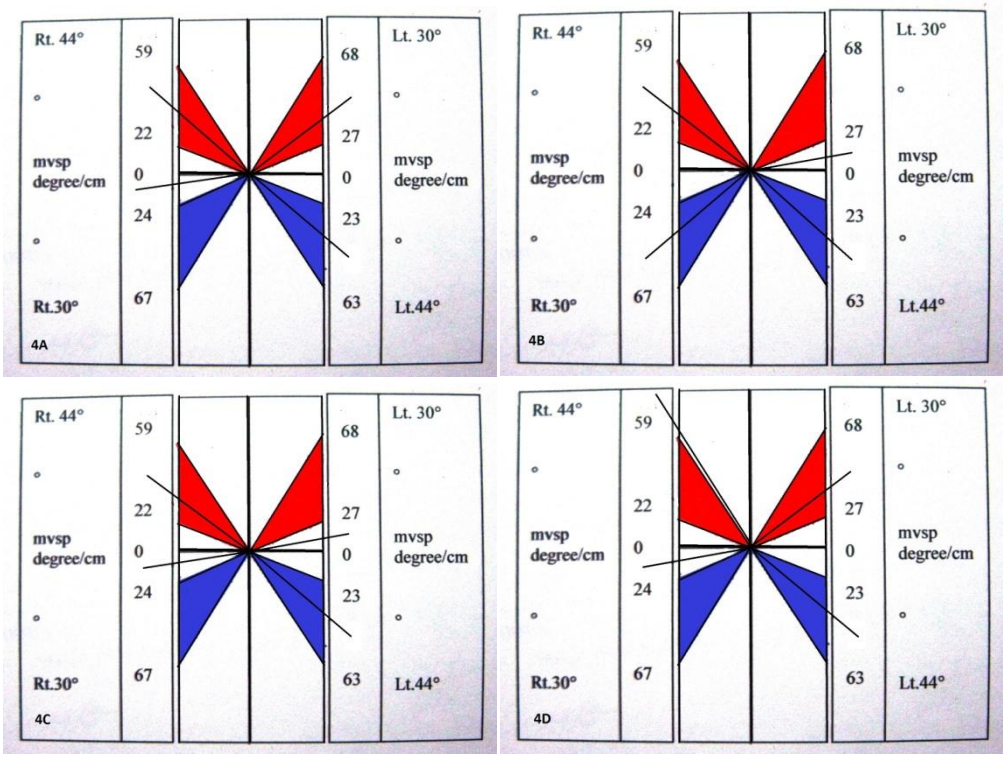

Fig. 4A, 4B, 4C, 4D Inhibition of peripheral cold response Trinary codes "0100", "0001", "0101", "2100" respectively

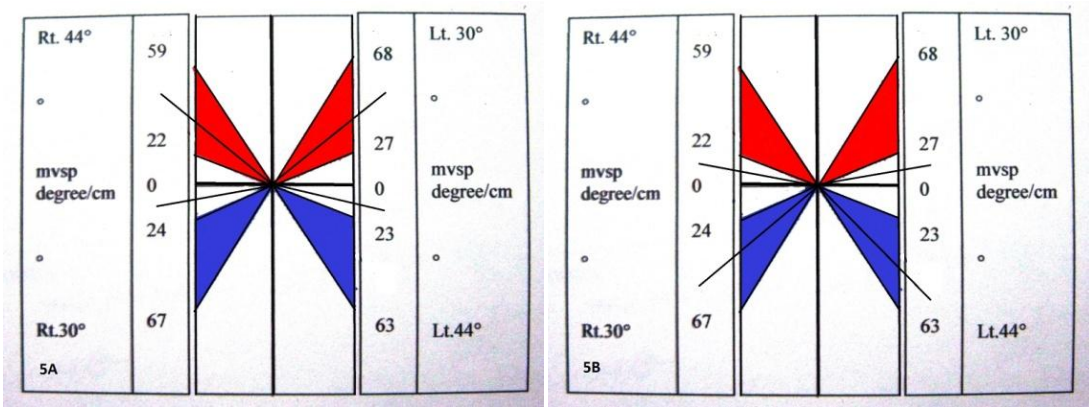

Fig. 5A, 5B Central nystagmus inhibition, Trinary codes "0110", "1001" respectively

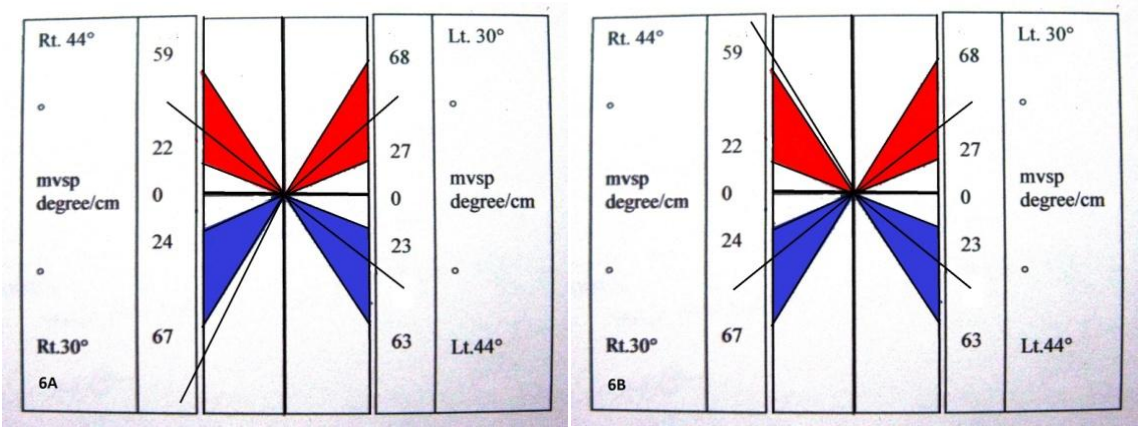

Fig. 6A, 6B Central lesions with hyper response of peripheral receptor, Trinary codes "0200", "2000" respectively.

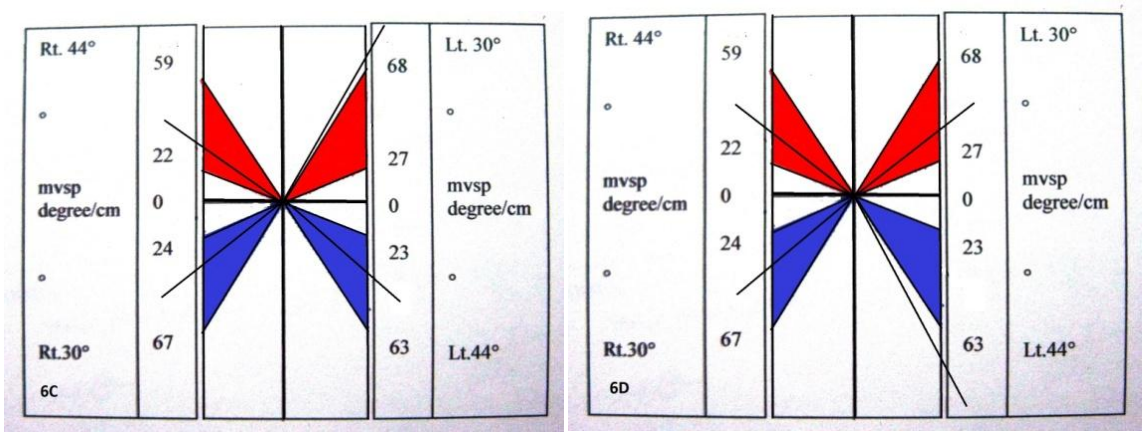

Fig. 6C, 6D Central lesions with hyper response of peripheral receptor, Trinary codes "0002", "0020" respectively.

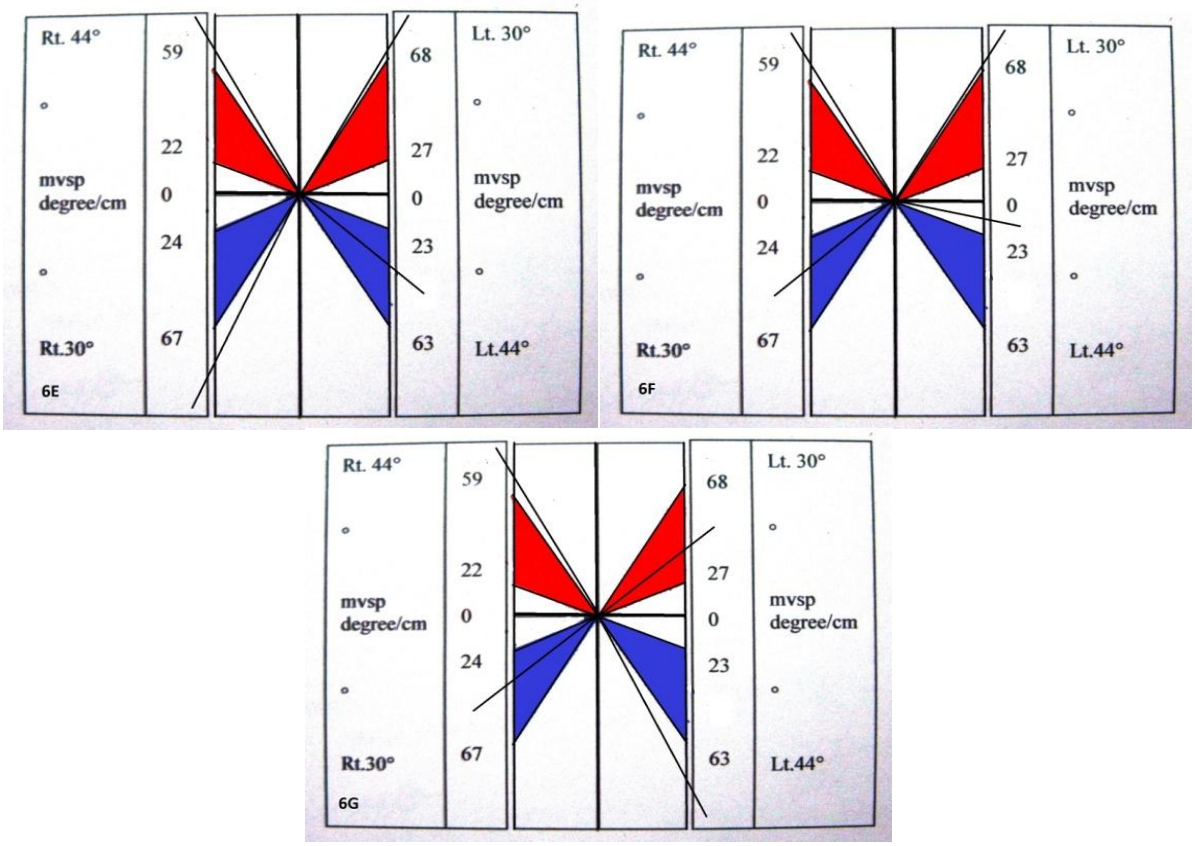

Fig. 6E, 6F, 6G Central lesions with hyper response of peripheral receptor, Trinary codes "2202", "2012", "2020" respectively.

VI. Conclusion

Over the years there is a constant rise in number of patients with vestibular dysfunction. It is clear from this study that age is no bar for occurrence of vertigo as it has been observed to range from 7 -88 years of age; However higher incidence was found between third to sixth decades of life. It has also been observed in this study that there is an increase in the number of females suffering from vertigo as the male: female ratio 5:1 in earlier studies now stands at 1.32:1. The importance of a detailed history with a complete neuro-otological examination is of utmost importance. Relevant routine examination and biochemical tests are helpful to rule out systemic causes of vertigo. ENG is an essential investigation in a vertigo work up and it should be done before a CT scan or an MRI of brain as the incidence of peripheral vertigo is 87.99% and causes of central inhibition or central disinhibition are 8.33% and 3.68% fall in the category of a mixed or indeterminate pathology. More

research is required to identify the butterfly patterns which have not appeared in this study or have occurred with a frequency of less than 1%.

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