Effect of head circumference on parameters of pattern r eversal Visual evoked potential in healthy adults of central India

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ABSTRACT

Visual evoked response testing has been one of the most exciting clinical tools to be developed from neurophysiologic research in recent years and has provided us with an objective method of identifying abnormalities of the afferent visual pathways. Investigation were carried out to see whether the head circumference influence the pattern reversal visual evoked potential (PRVEP) parameters. The study comprised of pattern reversal visual evoked potential (PRVEP) recordings in 400 eyes of 200 normal subjects. Two hundred fourty eight eyes were males and 152 eyes were from 76 female subjects recruited from the Central Indian population in the age range of 40-79 years. Visual evoked potential (VEP) recordings were performed in accordance to the standardized methodology of International Federation of Clinical Neurophysiology (IFCN) Committee Recommendations and International Society for Clinical Electrophysiology of Vision (ISCEV) Guidelines and montages were kept as per 10-20 International System of EEG Electrode placements. The stimulus configuration in this study consisted of the transient pattern reversal method in which a black and white checker board was generated (full field) and displayed on a VEP Monitor by an electronic pattern regenerator inbuilt in an Evoked Potential Recorder (RMS EMG EP MARK II). VEP latencies, duration and amplitude were measured in all subjects and the data were analyzed. The correlation of all the electrophysiological parameters with head circumference was evaluated by Pearson's correlation co-efficient (r) and its statistical significance was evaluated. The prediction equations for all the VEP parameters with respect to head circumference were derived. We found a positive correlation of P 100 latency and N 155 latency with mean head circumference, while a highly significant negative correlation were noted of P 100 amplitude with head circumference. N 70 latency was significantly correlated with head circumference. P 100 duration showed in negative correlation with head circumference. These findings suggest that VEP latencies, duration and amplitude are influenced by the head circumference of the individual in a sample of healthy subjects and head circumference can be a useful predictor of VEP peak latencies, amplitude and duration.

Keywords: Pattern reversal, P100 latency, P100 amplitude, P100 duration, N70 Latency, N155 latency.

INTRODUCTION

Visual evoked potential (VEP) is a graphic illustration of the cerebral electrical potentials generated by the occipital cortex evoked by a defined visual stimulus.[1] Transient Pattern Reversal Visual Evoked Potential generated in the cortical and sub-cortical visual areas when the retina is stimulated with pattern light is a very important non-invasive low-cost method and highly objective tool in detecting abnormalities of visual system. The normal VEP indicates the intactness of the visual system.[2]

A number of factors that influence VEP waveform include the age, gender, height and head circumference of the subject but it is observed that there is not much data available in literature regarding changes in the visual evoked responses with all these parameters especially in this part of the world. Therefore an attempt was made by us to study the influence and correlation of head circumference with VEP in healthy adults of Central India. The aim was to record the VEP waveform and evaluate its parameters in healthy males and females having normal visual acuity in the age group of 40-79 years.

MATERIALS AND METHODS

A total of 200 control subjects were included in this study. Out of these, 124 (62%) were males and 76 (38%) were females.

The mean age for males was 57.17 ± 10.92 years (range from 40-79 years) Similarly, for females the mean age was 54.30 ± 10.62 years (minimum age of 40 years and maximum of 79 years).

Approval from the Institutional Ethics committee was obtained for the study. Written Informed consent were also taken from the volunteers before the study after explaining the details of the investigation.

Detailed systemic and thorough ophthalmological

examination were carried out for all the subjects. In this study, we included only patients with good visual acuity (6/6 or better with or with out corrective glasses) because this helped to limit the influence of lens changes. Subjects were interviewed and the details of the subject regarding habits, occupation, medical history of systemic illness like hypertension, diabetes, tuberculosis, thyroid disorders and family history were entered in a standardized proforma. Any person with the history of above illness (past or present) were excluded from the study.

The head circumference of the subject was measured by using measuring tape around glabella and inion. Measurements were taken by the same person.

INCLUSION CRITERIA:

- Best-corrected visual acuity 6/6 (with or without corrective glasses).
- IOP <21 mmHg (as measured by the Non contact tonometer)
- Full and Normal field of vision
- Open angle at gonioscopy,
- Normal optic nerve head and retinal nerve fiber layer on clinical examination,
- Normal pupillary size (2-4mm) and reactions
- (8) Normal Fundus and optic disc

The subjects did not show any abnormality in the ophthalmic evaluation, including slit-lamp examination, tonometry, perimetry, and ophthalmoscopy.

EXCLUSION CRITERIA:

- Visual acuity (BCVA) <6/6
- Glaucoma / Ocular Hypertension
- Multiple sclerosis, optic neuritis and papilloedema
- Lens/ corneal opacities
- Diseases involving macula or visual pathway,
- Hereditary disorders/Retinitis pigmentosa /Albinism
- Diabetes mellitus
- History of relevant neurological or heart disease or of drug abuse.
- Past history of serious visual problems
- Miotic pupil
- High myopia, hypermetropia or astigmatism > 3 diopters
- Previous intraocular surgery except for uncomplicated cataract extraction and
- Parkinson's disease

Any unco-operative subject or a subject with incomplete screening and examination was excluded from the study.

METHODOLOGY FOR VEP

VEP recordings were done in accordance to the standardized methodology of International Federation of Clinical Neurophysiology (IFCN) Committee Recommendations[3] and International Society for Clinical Electrophysiology o f Vision (ISCEV) Guidelines[4] and montages were kept as per 10-20 International System of EEG Electrode placements.

STIMULUS PARAMETERS

The stimulus configuration in the present study consisted of the transient pattern reversal method in which a black and white checker board was generated (full field) and displayed on a VEP Monitor by an electronic pattern regenerator inbuilt in an Evoked Potential Recorder (RMS EMG EP MARK II) manufactured by the Recorders and Medicare Systems, Chandigarh. Individual checks subtended a visual angle of 2.2° and the entire pattern 18° at the eyes of the subject. All checks were square and there were an equal number (8) of white and black checks. This was accomplished by displaying 8×8 checker board pattern on the computer screen using Visual Basic software (Fig. 1).

A fixation point (red square) was positioned at a corner of four checks which were located at the center of the field.

- The rate of pattern reversal was 1 Hz.
- The recording sensitivity was kept at 2μV.
- The electrode impedance was kept below 5KΩ.

The analysis time (sweep duration) was maintained at 300 ms. Responses to 200 stimuli (epochs) were amplified and averaged for each eye and two trials for each eye were

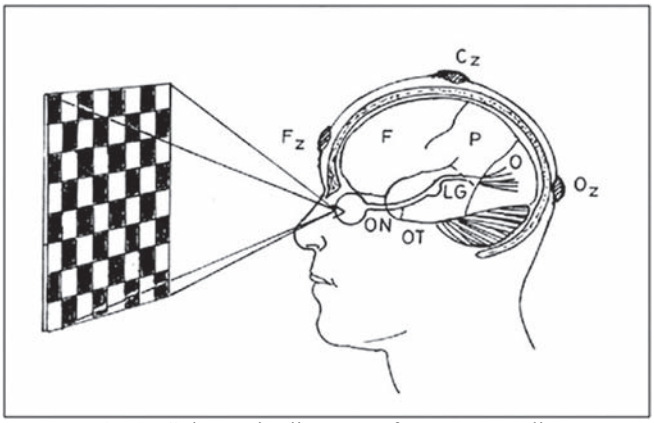

Fig 1. Schematic diagram of VEP Recording
ON= Optic Nerve, OT= Optic Tract, LG= Lateral Geniculate Body F= Frontal Lobe, P= Parietal Lobe, O= Occipital Lobe, Fz, Cz, Oz = Midline frontal, vertex, occipital positions respectively.

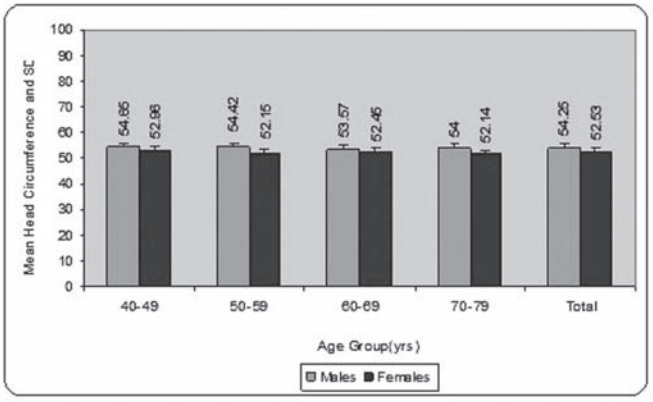

Fig 2. VEP Record of 41 Years Female Subject
PRVEP record showing P100 latency and amplitude WNL in both eyes.

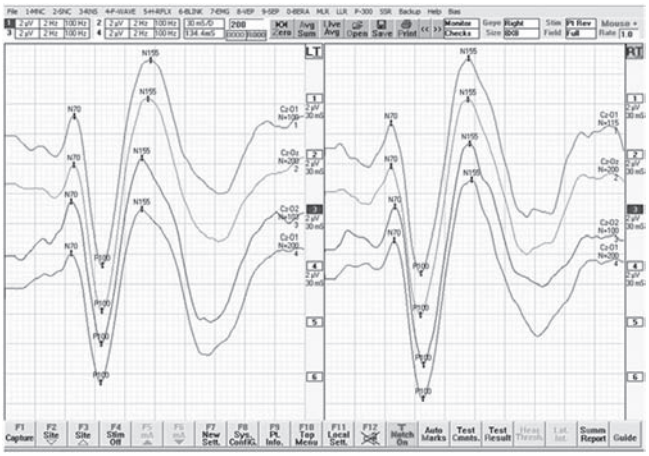

Fig 3. Age and Sex distribution for head circumference

obtained. The pattern stimulus luminance was 59 cd/sqm and the contrast between black and white squares (as defined by Michelson contrast) was kept as 80%.

The signals recorded were filtered by low cut and high cut frequency filter through a band spread of 2-100 Hz.

SUBJECT PREPARATION

Each subject was briefed previously about the procedure and was seated comfortably at a distance of 1 meter away from the screen of the VEP monitor.

ELECTRODE PLACEMENT

Standard silver-silver chloride disc EEG electrodes were placed on the scalp areas according to the 10-20 International System of EEG Electrode placements-

- the reference electrode (Fz) was placed at the forehead,
- the ground electrode (Cz) at the vertex and
- the active electrode (Oz) at approximately 2 cm above the inion.

VEP WAVEFORM

The PRVEP waveform consisted of the initial negative peak (N70) followed by a large positive peak (P100) and followed by another negative peak (N155) (Fig. 2). The analysis of all the three waves namely N70-P100-N155 has been attempted in the present study contributing to its unique features apart from the inclusion of P100 duration (interpeak latency) as well in the analysis. The absolute difference in the components evoked by the right eye and left eye stimulation (inter ocular differences) were also determined.

RESULTS

Fig.3 represent the age and sex distribution for head circumference in the subjects. The mean of the 124 males was 54.25±1.60 cm, the range being from 50-58 cm. Among the 76 females, the mean head circumference was 52.53±1.42 and the range of head circumference was seen to be from 50-57 cm. The average head circumference of 200 subjects was 53.60±1.75 cm.

The correlation of mean VEP parameters of RE and LE of the subjects with mean head circumference as shown in Table-1 provides the implication that all the parameters were positively correlated with head circumference except P100 amplitude which showed statistically significant negative correlation and P100 duration which showed non-significant negative correlation with head circumference.

Table-2 summarises the correlation of mean head circumference mean VEP parameters of both eyes of the subjects. The remarkable feature is a significant negative correlation of P100 amplitude with head

Table-1: Correlation of Head circumference with VEP parameters of right and left eyes

Parameters	Mean ± SD	r	p-value	Mean ± SD	r	p-value
Head circumference (cm)	53.60 ± 1.75	-	-			
	Right Eye			Left eye		
N70 Latency (msec)	66.63 ± 5.91	0.134	>0.05	66.64 ± 5.74	0.072	>0.05
P100 Latency (msec)	98.24 ± 4.45	0.081	>0.05	97.65 ± 4.47	0.071	>0.05
N155 Latency (msec)	135.47 ± 8.42	0.014	>0.05	135.40 ± 8.63	0.014	>0.05
P100 Amplitude (μV)	5.60 ± 2.17	-0.162	<0.05	5.74 ± 2.25	-0.147	<0.05
P100 Duration (msec)	68.83 ± 9.73	-0.094	>0.05	68.75 ± 9.96	-0.030	>0.05

circumference. As regards N70 latency, P100 latency and N155 latencies, they were positively correlated with head circumference but the correlation was a non-significant one. P100 duration showed a non-significant negative correlation with head circumference. Fig.4 shows scatterograms of VEP parameters with head circumference.

Table-3 shows the calculated Prediction Equations for all the VEP parameters with respect to head circumference of the individual. From these equations, corrected VEP parameters could be derived.

Table-2: Overall Correlation of head circumference with VEP parameters of both eyes

Parameters	Mean ± SD	r	p-value
Head circumference (cm)	53.60 ± 1.75		
N70 Latency (msec)	66.64 ± 5.59	0.108	>0.05
P100 Latency (msec)	97.94 ± 4.24	0.080	>0.05
N155 Latency (msec)	135.44 ± 8.31	0.000	>0.05
P100 Amplitude (μV)	5.67 ± 2.16	-0.158	<0.05
P100 Duration (msec)	68.79 ± 9.49	-0.064	>0.05

DISCUSSION

We found N70 latency, P100 latency and N155 latencies were positively correlated with head circumference. Similar positive correlation of P100 latency only with head

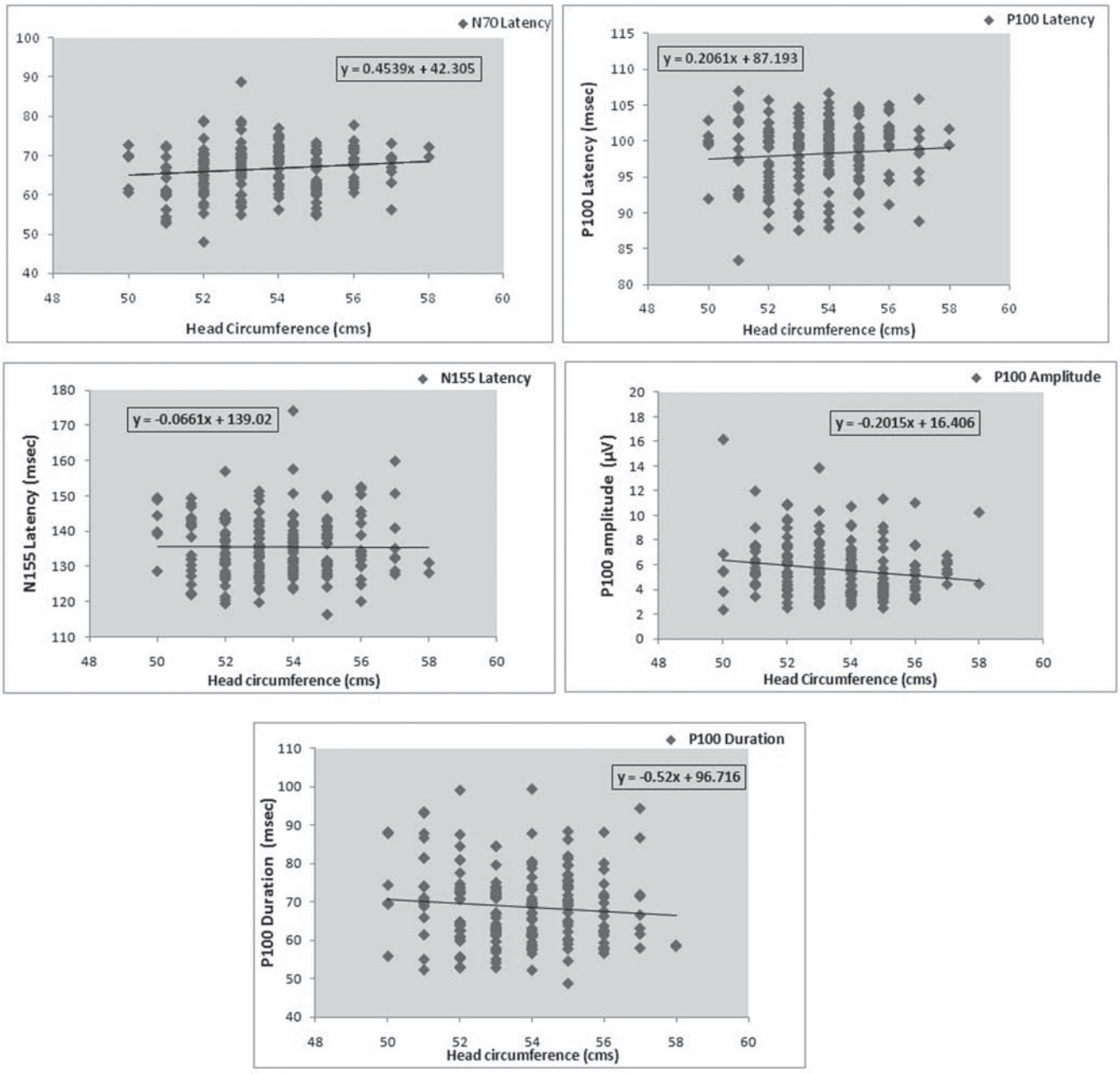

Fig 4. Scatterograms of VEP Parameters with head ci

Table-3: Prediction equations for VEP Parameters and head circumference of individual

S.No.	VEP Parameter	Prediction Equation
1	N70 latency	y = 0.4539x + 42.305
2	P100 latency	y = 0.2061x + 87.193
3	N155 Latency	y = -0.0661x + 139.02
4	P100 Amplitude	y = -0.2015x + 16.406
5	P100 Duration	y = -0.52x + 96.716

Where y is VEP parameter and x is head circumference of individual

circumference had been reported in an earlier study [5] whose results indicated that a major determinant of differences in latency of P100 in adults is head size. A significant correlation had been reported between head circumference and axial eye length in the past[6] which supported our finding. This factor influences the VEP parameters as larger head circumference indicates the larger brain size and a longer conduction pathway thus prolonging VEP latencies and duration. The differences for these parameters existed even between the sexes. Smaller brain size suggestive of shorter optic pathways[7,8] may be a probable cause of shorter latency observed in our study with smaller head circumference. The assumption that the anatomic variation is isometric, differences in all dimensions will be proportional and any pathway in brain will vary in length as cube root of brain volume [9] supports our observation of prolonged latencies with larger head circumference.

A significant negative correlation of P100 amplitude with head circumference was observed by us. Such a correlation has not been reported earlier as far as literature could be traced. However when mean P100 amplitude in normal population of the present series were compared with that of western countries[10,11,12,13]. It was revealed that there was one difference between the mean P100 amplitude of present subjects (5.67±2.16 μV) were smaller as compared to that of the value of mean P100 amplitude in western studies. This disparity of the magnitude of P100 amplitude between studies in western subjects and the present study could be caused by the differences in height, in age and sex matched Indians and Caucasians which is also reflected in the mean VEP parameters of this population.

There was a highly significant negative correlation ($p<0.001$) of P100 amplitude with head circumference in various age groups of normal population of Central India. N70 latency was found to be positively correlated ($r=0.243$) with head circumference and it was a statistically significant correlation. The positive correlation between VEP latencies and increasing head circumference may all reflect the increase in length between the optic nerve head and the visual processing areas-the striate and the extra striate cortex which are the main generators of the various PRVEP waveforms.

SIGNIFICANCE OF THE STUDY

Head circumference of the individual is a useful predictor of VEP peak latencies, amplitude and duration so it should be considered for VEP normative studies and corrected VEP parameters could be derived by the prediction equations put forth by this study.

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