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EFFECT OF GENDER, HEAD CIRCUMFERENCE & OTHER ANTHROPOMETRIC PARAMETERS ON VISUAL EVOKED POTENTIAL IN HEALTHY YOUNG INDIVIDUALS

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Abstract

Introduction: Visual evoked potentials (VEPs) refer to recorded scalp potential variances triggered by visual stimuli and are typically elicited through repetitive stimulus presentations. This study's primary objective was to establish standard reference values for visual evoked potentials in a cohort of healthy young individuals residing in Tamil Nadu. **Methodology:** The research was conducted with a sample comprising 100 healthy medical students from Medical College, Tamil Nadu, aged between 17 and 20 years, evenly split between 50 males and 50 females. Various anthropometric measurements, such as age, height, weight, BMI, and head circumference, were gathered for all participants. VEP recordings were obtained using a PC-based, 2-channel RMS EMG EP Mark II apparatus, employing standard silver-silver chloride disc electrodes. To elicit pattern reversal responses, a VEP monitor featuring a checkerboard pattern was employed. The VEP parameters that were recorded encompassed the latencies of the N75, P100, and N145 waves, as well as the peak-to-peak amplitude of the P100 wave. **Results:** Our findings revealed that the mean latencies of N75, P100, and N145 waves exhibited no significant differences, and the mean amplitude of the P100 wave showed no significant variation ($p > 0.05$). Furthermore, it was observed that neither age nor body mass index had a notable influence on the VEP parameters. **Conclusion:** Gender represents a noteworthy physiological factor when determining standard reference values for VEPs. A minor distinction in VEP parameters is evident between the sexes.

Keywords: Visual Evoked Potential, Anthropometric Parameters, Head Circumference, P100 Latency, Visual Pathway.

INTRODUCTION

Evoked potentials provide a measure of the functional changes of the sensory systems during different stages of life[1]. Visual evoked potential (VEP) is a graphic illustration of the cerebral electrical potentials generated by the occipitalcortex evoked by a defined visual stimulus[2]. VEP is used to assess the visual pathways through the optic nerves and brain and may be affected by variety of physiological factors including age, sex, visual acuity and pupillary size. VEPs are tests of the central part of the visual system, the macula and the visual cortex. They can be used to check if the macula and the visual cortex are working properly, and to check if the electrical signals are being transmitted correctly along the visual pathways[3,4].

The Visual Evoked Potential (VEP) is a highly valuable non-invasive technique for identifying visual system irregularities. Its significance extends beyond clinical neurophysiologists and ophthalmologists; it is also of great importance to neurologists and neurosurgeons, as numerous neurological conditions manifest with visual issues. VEP can be influenced by a range of physiological factors, such as age, gender, pupil

size, and visual acuity, as well as technical factors like check size, luminance, field size, and more[5].

Gender has been recognized as an important physiological factor which can affect both the amplitude and latency of pattern reversal VEP parameters. But controversies exists confounding the findings. Ruby Sharma et al observed that the VEP changes are appreciated between genders while Guthkelch et al discusses the non relevance of gender to VEP changes [6,7]

Studies on normal subjects are required at the regional level to determine the standards for VEP parameters and the factors affecting it.

It represents a resultant response of cortical as well as subcortical areas to photo stimulation. It was first observed by Adrian and Mathews that fleshing light can induce a stimulus dependent change of brain activity [8].

VEP is primarily a reflection of activity originating in the central 3° to 6 ° of visual field, which is relayed to the surface of occipital lobe. The transie nt VEPs consist of series of waveforms of opposite polarity, the negative waveform is denoted as N and positive waveform is denoted as P, which is followed by the approximate latency in millisec[9].

The commonly use waveform areN70, P100 and N155. The P100 waveform of VEP is generated in occipital cortex due to activation of primary visual cortex and also due to thalamocortical fibers.

VEP results from normal subjects should be available in the neurophysiology laboratory to compare the results of a given subject to see if they are normal. It is important to note that VEP normative values vary from lab to lab, so it is best for each lab to have its own normative data. Studies on normal subjects are needed in each population to determine the normative VEP values and the factors that affect them[3].

Therefore, the present study has been planned on healthy medical students to determine the normal values and to investigate the effect of gender and anthropometric parameters (Height, weight, Body mass Index, Body Surface Area and Head size) on VEP.

Pattern Reversal Visual Evoked Potential generated in the cortical and sub-cortical visual areas when the retina is stimulated with pattern light. It is observed that there is not much data available in literature regarding changes in the visual evoked responses with all these parameters especially around south India. Therefore, an attempt has been made to study the influence and correlation of head circumference & gender difference with VEP in healthy adults of South India.

Aim

To record the VEP waveforms & evaluate its parameters in healthy males & females having normal visual acuity.

MATERIALS & METHODS

This study which was carried out at the clinical neurophysiology laboratory of the Sri Venkateshwara Medical College, Pondicherry from February 1st to May 30th, 2016. Total participants were 101 members (50 males and 51 females) in the age group of 17-20 years. The anthropometric parameters including age, height, weight, BMI, BSA and Head circumference were recorded in all the subjects.

A total of 101 subjects were included in this study. Visual acuity was tested. The present study was carried out on healthy subjects who agreed to participate in the study. In this study, we included only patients with good visual acuity (6/6 or better with or without corrective glasses). The head circumference and other anthropometric measurements were of the subject. Inclusion criteria for the study include participants who are males and females between the ages of 17 and 20 years. They should have 20/20 vision with or without glasses, and their field of vision should be normal and complete.

Exclusion criteria for the study include individuals with visual acuity less than 6/6, those with glaucoma or ocular hypertension, individuals with lens or corneal opacities, those with hereditary disorders like retinitis pigmentosa or albinism, individuals with diabetes mellitus, high myopia, hypermetropia, or astigmatism, and those who have undergone previous intraocular surgery. Ophthalmological examination, visual acuity with Snellen's charts was done to rule out any visual disorder. The subject was instructed to take a sound sleep.

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[7].

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. Then, a monocular recording separately for the left and the right eyes was done on an evoked potential Recorder.VEP was recorded with a PC based, 2 channel, RMS EMG EP mark II machine and standard silver-silver chloride disc electrodes. A VEP monitor displaying checker board was used to give the pattern reversal stimulus. The recording was done in a dark room with quiet surroundings.

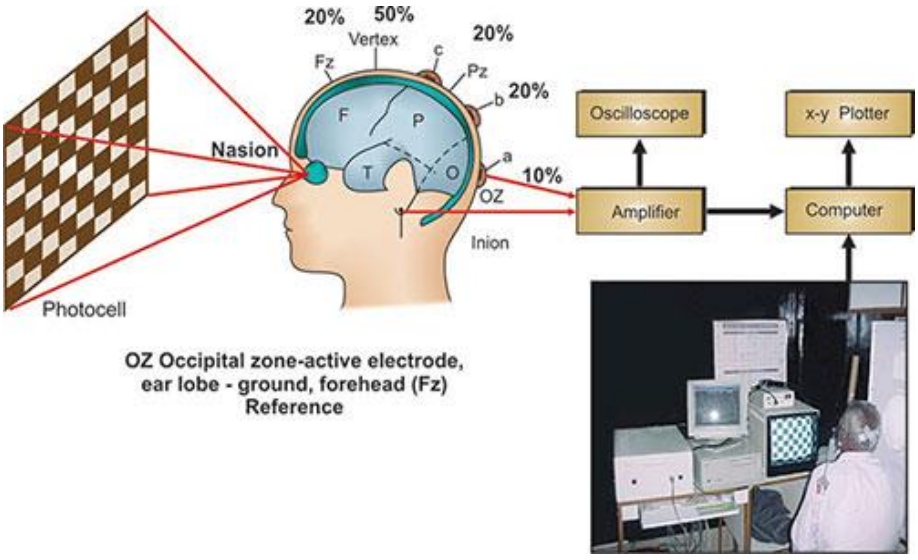

Figure 1: Image showing a subject in a VEP recording session in the clinical neurophysiology laboratory

Specific attempt was made to ensure that the subject maintained his fixation at the central red point throughout the recording. Each subject was allowed to rest for 5-10 minutes after each recording, typically with their eyes closed. VEP latencies, duration and amplitude were measured in all subjects and the data were analyzed.

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). The analysis of all the three waves namely N70-P100-N155has been attempted in the present study.

Statistical Analysis:

Data analysis was carried out by EPI-INFO version 7.2. Alpha was be set at level of 5%, and all statistical tests reported were two-tailed (with normal distribution) using Student's t-test for comparisons of means between groups 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.

RESULTS

The present study tested VEP latencies and amplitude in age matched healthy subjects divided into male and female groups with each group having 50 subjects. The average age of male and female group was quite similar. The average height and weight of male subjects was significantly higher as compared to female subjects but BMI (Body Mass Index) differed only slightly between the two groups and that too was statistically insignificant (Table 1).

Table 1: Physical parameters of Male (N=50) and Female (N=51) group

Data	Males (Mean ± SD)	Females (Mean ± SD)	P Value
Age (Yrs)	20.31 ± 0.90	19.30 ± 0.98	>0.05
Height (cm)	159.12 ± 6.77	154.87 ±5.32	< 0.05*
Weight (Kg)	64.47± 10.13	58.62± 8.94	<0.05*
BMI (Kg/m2)	22.28 ± 4.12	21.62 ± .74	>0.05
Head Circumference(cm)	55.09 ± 2.43	54.66 ± 2.23	>0.05

* Statistically significant

Latencies of all the waves of PRVEP were found to be longer in male group as compared to female group both in right eye as well as the left eye. However, the difference was not statistically significant (p value > 0.05). A statistically insignificant slight difference in amplitude of P100-N75 (higher in females) was also observed in both the eyes for two groups (Table 2, Table 3).

The table 4 you provided shows the correlation coefficients (r) between anthropometric parameters (height, weight, BMI, BSA, HC) and VEP parameters (N70, P100, N155, Amp) in both left and right eyes. All of the correlation coefficients are statistically significant at the 0.05 level (2-tailed), which means that there is a relationship between the anthropometric and VEP parameters.

The correlation coefficients range from 0.016 to 0.565, with higher values indicating stronger correlations. The strongest correlations are between weight and all of the VEP parameters, with correlation coefficients ranging from 0.521 to 0.565. This means that people with a higher weight tend to have higher values for all of the VEP parameters.

Table 2: Comparison of Latencies and Amplitude of PRVEP waveforms in Right Eye b/w Male and Female group

Wave	Males (Mean± SD)	Females (Mean ± SD)	P Value
N75	73.09 ± 21.86	69.93 ± 17.46	<0.05
P100	112.98 ± 31.15	108.48 ± 23.45	>0.05
N145	169.36 ± 22.04	165.60 ± 19.68	<0.05
Amplitude P100	10.30 ± 4.20	9.60 ± 3.65	<0.05

Table 3: Comparison of Latencies and Amplitude of PRVEP waveforms in Left Eye b/w Male and Female group

Wave	Males (Mean± SD)	Females (Mean ± SD)	P Value
N75	75.50 ± 15.80	72.87 ± 13.21	>0.05
P100	115.65 ± 22.90	111.92 ± 17.56	>0.05
N145	169.98 ± 33.66	164.67 ± 24.55	>0.05
Amplitude P100	9.46 ± 4.35	8.70 ± 3.82	>0.05

The table 4 shows that there are generally moderate to strong correlations between the anthropometric and VEP parameters. This suggests that there are relationships between the variables, but that the relationships are not perfect.

Table 4: Correlation coefficient 'r' between anthropometric and VEP parameters

Parameter	Left Eye				Right Eye			
	N75	P100	N145	Amp	N75	P100	N145	Amp
BMI	0.08	0.065	0.116	0.129	0.124	0.094	0.038	0.159
HC	0.248**	0.048	-0.14	0.119	0.175**	-0.044	-0.158	0.191**

It is important to note that correlation does not imply causation. Just because there is a correlation between two variables does not mean that one variable causes the other. It is possible that there is a third variable that is causing both variables to change.

More research is needed to determine the underlying causes of the correlations observed in the table. However, the results suggest that there is a relationship between anthropometric parameters and VEP parameters. This information could be used to develop new diagnostic tools or treatments for conditions that affect the visual system.

Table 5: correlations between BMI and LP100

Variable	Pearson Correlation	Sig. (2-tailed)	N
BMI and LP100	-0.065	0.521	101

Table 5 shows that there is a weak negative correlation between BMI and LP100. This means that as BMI increases, LP100 tends to decrease, but the correlation is not strong. The significance value (p-value) of 0.521 is greater than 0.05, which means that the correlation is not statistically significant.

The table 5 shows the correlation between BMI and LP100. The Pearson correlation coefficient is -0.065, which is a weak negative correlation. This means that there is a small, negative relationship between BMI and LP100. The p-value for the correlation is 0.521, which is greater than 0.05. This means that the correlation is not statistically significant.

In other words, the evidence suggests that there is a small, negative relationship between BMI and LP100, but that this relationship is not likely due to chance. However, more research is needed to confirm this finding and to determine the underlying causes of the relationship. People with a higher BMI tend to have a slightly lower LP100. This could be due to a number of factors, such as: Increased adiposity (body fat), Decreased muscle mass, Decreased blood volume

The correlation coefficient is weak, which suggests that there are other factors that can also influence LP100. These factors could include: Age, Sex, Ethnicity, Diet, Exercise and Medical conditions.

Table 6: correlations between head circumference and LP100

Variable	Pearson Correlation	Sig. (2-tailed)	N
Head circumference and LP100	0.048	0.634	101

Table 6 shows that there is a weak positive correlation between head circumference and LP100. This means that as head circumference increases, LP100 tends to increase as well, but the correlation is not strong. The significance value (p-value) of 0.634 is greater than 0.05, which means that the correlation is not statistically significant. In other words, the evidence suggests that there is no true relationship between head circumference and LP100. One possible interpretation of the correlation coefficient is that people with larger head circumferences tend to have slightly higher LP100 values.

This could be due to a number of factors, such as, People with larger head circumferences tend to have larger brains. The brain is a major consumer of blood, so a larger brain may require more blood flow, which could lead to higher LP100 values. People with larger head circumferences may also have thicker skulls. A thicker skull could protect the brain from injury, but it could also make it more difficult for blood to flow to the brain. This could lead to lower LP100 values. There are many other factors that could also influence the relationship between head circumference and LP100, such as age, sex, ethnicity, diet, exercise, and medical conditions.

DISCUSSION

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 visual pathways.[1]

Age being a proven factor affecting VEP[2,3] in the present study focus was to highlight the effect of gender.

P100 Latencies of VEP in Various Studies

Author and year	Number of subjects	P100 Latencies of VEP (ms)
Celesia et al, 1987	112	98.1±4.4
Guthkelch, 1987	16	100.04±3.9
Shin et al, 1988	30	107(M),106(F)
Mishra and Kalita et al, 1999	58	96.9±3.6
O P Tandon et al 1999	27	95.3±6.8
Jayshree Pet al 2008	146	97.6±2.28
Jayesh D. Solanki et al 2010	48	100.53±0.45(M), 100.44±0.89(F)
Jayshree Phurailatpam et al 2014		97.6±2.3;
Present study	100	112 ± 31.15(M), 108 ± 23.45(F)

The results of our study are in agreement with other such studies which also reported no significant gender difference in VEP parameters[1,2]. On the contrary, some studies reported significant difference in VEP parameters between two sexes[6,7]. Gregori et al investigated the influence of gender and head size on VEP latencies. He found out that P100 latency was slightly shorter in females than males and this small difference reached weak statistical significance ($p < 0.05$) whereas head size differed significantly ($p < 0.001$) between sexes (females < males). No difference was found in the P100 latency in the subgroup of the two sexes with a comparable range of head size. He concluded that the slight sex difference observed in P100 latency was mainly because of slightly smaller average head size in females than in males and head size, not sex, should be considered for VEP latency normative studies[8]. Recently, Dion et al analyzed the sex differences in VEP parameters in school-age children. They observed shorter latencies in girls appeared mostly due to head size[9]. The difference in VEP latencies between two genders can also be attributed to factors like shorter axial eye length in females as compared to males;[10] early cerebral maturation in female children as evidenced by increased alpha frequency and greater photo sensitivity in females than males;[11] comparatively smaller brain size in females;[12] 2-5 ms faster reaction time in females than males[13] or because of some hormonal factors[14]. Statistically insignificant inter-ocular difference in P100 latency that was observed between two sexes can be due to either lateralization of central nervous system or neuroanatomical asymmetry[15]. Presence of significant inter eye difference rather becomes a proof of some monocular disease.

CONCLUSION

Every neurophysiological laboratory doing VEP studies should have its normative data for future reference. There is a definite gender difference in VEP parameters with females showing shorter P100 latencies and higher amplitudes. This gender difference may be due to anatomical or endocrinal differences in the two sexes.

Limitation:

This study was limited by its small sample size, which means that the results may not be generalizable to the wider population. Therefore, it is important to replicate this study in other settings with larger samples to confirm the findings.

Ethical Approval:

This study was conducted in accordance with the Declaration of Helsinki-Ethical principle for medical research involving human subjects. Accordingly, the ethical clearance was obtained from Institutional Human Ethics Committee, Sri Venkateshwara Medical College, Pondicherry**.** All individuals who took part in the study gave their informed consent, and data confidentiality was ensured.

Data Availability:

All datasets generated or analyzed during this study are included in the manuscript.

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Conflicts of Interest: No potential conflict of interest was reported by the authors.

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Authors' Contributions:

Dr. Dhivya. K: Conceived the idea, principal investigator of the research work, Supervision and Literature Review.

Dr. Suganya G: Designed the study protocol, Discussion writing, Proof reading and drafted the manuscript.

Dr. C. L.Gokila Preethi: Manuscript draft editing and conducted the statistical analysis

Dr. N.Anusuiya: Performed data collection, responsible for data's integrity and authenticity

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. All authors have read and agreed to the published version of the manuscript.

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