

Pattern Reversal Visual and Brain Stem Auditory Evoked Potentials: Influence of Gender, Head Circumference and Body Size in Normal Healthy Adults

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Original Research Article

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Article History

Received: 16.01.2018

Accepted: 25.01.2018

Published: 30.01.2018

DOI:

10.36347/sjams.2018.v06i01.049



Abstract: Evoked potential studies are important neurophysiological tests that are useful in investigating the physiology and pathophysiology of central and peripheral nervous systems. Age, sex, brain size and body size are a variety of physiological parameters that influence the evoked potential variables. Hence the present study is aimed to study the gender differences in healthy adults and also to find out effect of BMI and head size on different evoked potential parameters. Evoked potentials were recorded in 102 healthy adults in the age-group of 20-65 years using the Data Acquisition and Analysis System. The study group comprised of 55 males and 47 females. Means were compared between males and females by using the unpaired student t test and head size and BMI were correlated with parameters by Pearson correlation coefficient (r) and statistical significance was analyzed. The study demonstrated statistically significant differences between males and females in all the parameters of VEP and in interpeak latencies I-III and III-V of BERA. Also in this study, BAEP showed a positive correlation with head circumference and VEP revealed a significant correlation with BMI. We concluded that gender is an important variable along with BMI and head size affecting the VEP and BAEP parameters. Hence these should be considered while standardizing the normative data for lab and for using it as a clinical tool.

Keywords: Evoked potentials, gender, BMI, head size, latency.

INTRODUCTION

Evoked potential studies have emerged as highly sensitive, objective and non-invasive neurophysiological techniques that have widespread clinical utility in investigating the physiology and pathophysiology of human systems.

These are neurodiagnostic tools applicable to many fields [1], allowing assessment of conduction of sensory impulses in central [2] and peripheral [3] nervous system.

Pattern-Reversal Visual Evoked Potential (PRVEP) and Brainstem Auditory Evoked Potential (BAEP) both exhibit a normal variability due to various physiological factors including sex, age, brain and body size. These parameters show a considerable influence on evoked potential responses. A successful clinical application of the test, however, is not possible without the acquisition of a normative data adjusted to known confounding physiological variables.

PRVEPs record visually evoked electrophysiological signals extracted from the electroencephalographic activity in the visual cortex. Responses evoked by patterned stimuli constitute

pattern visual evoked potentials and pattern reversal is the preferred stimulus for most clinical purposes because of its relative simplicity and reliability with less intra-individual and inter individual variability [4].

BAEPs are recorded from the scalp as small voltage potentials after passing auditory stimuli through a headphone. These waveforms represent the neuro electrical activity that is generated by the neural generators in the auditory pathway between the cochlea and the brainstem. BAEP responses exhibit a normal variability due to various non pathologic factors and age is one of the variables suggested to have considerable influence on normal BAEP responses [5]. Hence, this study attempted to obtain PRVEP and BAEP values in different sex groups in healthy adults and also to evaluate the influence of head size and body mass index on PRVEP and BAEP variables.

MATERIALS AND METHODS

Evoked potentials were recorded by using the Data Acquisition and Analysis System, (Neurostim [NS4], Medicaid Systems, Chandigarh, India) in a sample of 102 healthy adults in the age-group of 20-65 years. This cross-sectional study was conducted in the Research lab of Physiology Department, GGS Medical College, Faridkot, Punjab, India. The study protocol was approved by the Institutional Ethics Committee (IEC) as per the guidelines of Helsinki declaration of 1975. Written informed consent was taken from all the enrolled subjects after explaining them the details of the study in their own language. A detailed clinical history and complete general physical examination of each subject was done. The height (cm) and weight (kg) of the subjects were measured and body mass index calculated as weight (kg)/height (meters)². Head size was measured (from nasion to inion) by a measuring tape prior to recording.

Participants

The study subjects comprised of 55 males and 47 females, aged 20 –65 years. These were selected randomly from among the apparently healthy relatives of the patients visiting the outpatient department of the hospital.

Exclusion criteria

The subjects were excluded from the study if suffering from any type of posttraumatic coma, neurological diseases (multiple sclerosis, brainstem tumor, and so forth), hearing and visual defects, history of drug abusing and other psychiatric disorders (mood disorder, organic brain disorder, personality disorder, and neurotic disorder).

Procedure

The test was explained to the subjects to ensure full cooperation, and the participants were instructed not to sleep during the procedure and the instrument was placed out of the view of the subject.

BAEP study

Equipment set up. Two channels were used (as per 10-20 international system of EEG electrode placement): Channel 1: Ai-CZ (active electrodes), Channel 2: AC-CZ, Ground: Fz. The subjects were allowed to sit comfortably in a fully relaxed state and

one ear was tested at a time. The skin at the point of placement of the electrodes was cleaned with spirits. Using electrode paste or conducting jelly, the recording electrodes were placed on both the ears; namely, ipsilateral (Ai), and contralateral ear (Ac), the reference electrode at vertex (Cz) and the ground electrode was placed at Fz. The brief click stimulus was delivered by shielded headphones, which is a square wave pulse of 0.1 ms duration. The low cut filter was set at 100 Hz and the high cut filter at 3000 Hz. The sweep speed was 1 ms/div and sensitivity was set at 0.5 vs./div. Two separate trials of 2000 responses were recorded and superimposed. Skin to electrode impedance was kept below 5 kohm.

VEP study

Equipment set up for VEP study was done as recommended by International Federation of Clinical Neurophysiology (IFCN) committee [6]. Two channels were used: Channel 1: Oz – Fpz, Channel 2 : OZ - A1A2 (linked ear), Ground: Cz. Keeping all the prerequisite conditions same, the recording electrode was placed at occiput (oz), the reference electrode at Fpz or 12cm above the nasion. The ground electrode was placed at the vertex (Cz). The visual stimulus was delivered by LED goggles using red flash of light. To record flash visual evoked potentials, the low cut filter was set at 2 Hz and high cut filter at 200 Hz. Sweep speed was 50ms/div and sensitivity was set at 2μ v/div. About 200 epochs were averaged. The electrode impedance was kept below 5 kohms.

STATISTICAL ANALYSIS

Values were expressed as means ± standard deviation. Means were compared between males and females by using the unpaired student t test using the Statistical Package for Social Sciences System version 16.0 (SPSS Inc., Chicago, IL, USA).. A simple correlation regression (r) was performed to determine the effects of brain size and BMI on different parameters of evoked potential studies. A *p*-value <0.05 was considered to be statistically significant.

RESULTS

In the present study, Evoked potentials were recorded in a sample of 102 healthy adults (47 males and 55 females) in the age-group of 20-65 years.

Table-1: Comparison of anthropometric parameters between female and male subjects

Parameter	Male (N=47) Mean ± SD	Female (N=55) Mean ± SD	P value	Significance
Age	19.50±3.26	19.42±3.10	>0.05	NS
Weight	58.86±10.08	47.12±8.52	<0.01	HS
Height	170.20±4.82	158.14±5.12	<0.01	HS
BMI	21.82±3.24	20.6±3.48	>0.05	NS
Head Circumference	56.27±2.1	53.6±1.43	<0.01	HS

Table 1 show the comparison of anthropometric data of both the female and male

subjects and revealed a statistically significant difference in height, weight and head circumference but

not in age and body mass index between the two groups.

Table-2: BAEP latencies and interpeak latencies in both ears of male and females (mean ± SD)

BAEP Parameters	Right ear			Left ear		
	Male (N=47) Mean ± SD	Female (N=55) Mean ± SD	P value	Male (N=47) Mean ± SD	Female (N=55) Mean ± SD	P value
I	1.58 ± 0.03	1.51 ± 0.01	>0.05	1.61 ± 0.23	1.63 ± 0.05	>0.05
II	2.73 ± 0.04	2.71 ± 0.04	>0.05	2.74 ± 0.02	2.66 ± 0.07	>0.05
III	3.62 ± 0.05	3.56 ± 0.02	>0.05	3.66 ± 0.04	3.65 ± 0.089	>0.05
IV	4.78 ± 0.19	4.81±0.17	>0.05	4.75 ± 0.04	4.65 ± 0.10	>0.05
V	5.48 ± 0.04	5.40 ± 0.08	>0.05	5.54 ± 0.04	5.45 ± 0.06	>0.05
I-III	1.95 ± 0.22	2.30±0.26	<0.001	2.40 ±0.06	1.96 ± 0.02	<0.01
III-V	2.04 ± 0.18	1.77±0.20	<0.001	2.02 ± 0.10	1.74 ± 0.04	<0.01
I-V	3.79 ± 0.09	3.76 ± 0.04	>0.05	3.91±0.08	3.81 ± 0.04	>0.05

Tables 2 depict the comparison of various BAEP latencies and interpeak latencies between males and females for left and right ear. It is evident from the results that for both ears, only two interpeak latencies I-

III and III-V showed a significant difference between males and females, rest all the peak latencies and IPL (I-V) were found to be statistically non-significant.(P > 0.05).

Table-3: VEP Latencies in both eyes of male and females (mean ± SD)

VEP Parameters	Right eye			Left eye		
	Female (N=55) Mean ± SD	Male (N=47) Mean ± SD	P value	Female(N=55) Mean ± SD	Male (N=47) Mean ± SD	P value
N70 latency	61.06 ± 6.5	64.35 ± 8.01	<0.05	63.73 ± 7.4	67.10 ± 8.7	<0.01
P100 latency	87.79 ± 9.01	92.50 ± 11.10	<0.05	88.31 ± 8.80	94.12 ± 9.66	<0.05
N155 latency	146.41± 10.11	151.10 ± 9.23	<0.01	145.75 ± 9.43	150.11 ± 10.51	<0.05
Amplitude P100	6.40±0.77	5.80±0.48	<0.01	6.40 ± 0.75	5.71±0.50	<0.01

Tables 3 depict the comparison of various VEP latencies and P100 amplitude between males and females for both left and right eye. It is evident from the results that for eyes, all the VEP latencies (N70, P100,

N155) and P100 amplitude showed a statistically significant difference between males and females. (P < 0.05).

Table-4: Correlation coefficients (r) for BERA variables with BMI and head circumference

BAEP Parameters	Correlation Coefficient (r)			
	BMI		Head Circumference	
	Left	Right	Left	Right
APL – I	-0.05	-0.04	0.040	-0.14
APL - III	-0.08	-0.03	0.04	0.006
APL – V	0.04	0.33	0.17	0.56*
I-III IPL difference	-0.06	-0.03	0.01	0.04
I-V IPL difference	0.08	0.17	-0.05	0.39*
III-V IPL difference	0.12	-0.02	0.16	0.31*
V/I ratio	0.08	0.09	0.08	0.15

APL- absolute peak latency; IPL- Interpeak latency; *significant positive correlation

Table 4 shows the correlation coefficient values of different BAEP parameters with BMI and head circumference. A significant positive correlation was observed in right ear between Vth wave latency and

head circumference and also between Inter peak latencies I-V and III-V and head circumference. But no correlation was observed between different BAEP variables and BMI.

Table-5: Correlation coefficients (r) for VEP variables with BMI and head circumference

VEP Parameters	Correlation Coefficient (r)			
	BMI		Head Circumference	
	Left	Right	Left	Right
N70 latency	0.503*	0.515*	-0.205	-0.218
P100 latency	0.506*	0.522*	-0.173	-0.205
N155 latency	-0.142	-0.123	-0.232	-0.215
Amplitude P100	0.237	0.233	0.001	0.004

*significant positive correlation

Table 5 shows the correlation coefficient values of different VEP parameters with BMI and head circumference. A statistically significant positive correlation was observed in both right and left eyes between N70 and P100 latency and BMI. But no correlation was observed between different VEP variables and head circumference.

DISCUSSION

The study investigated the influence of gender on BAEP and VEP latencies in healthy adults in age group of 20-65 years and inquired whether head circumference and BMI are source of variance responsible as a cause of gender difference or not. Results revealed that females had shorter latencies than males in all the parameters of VEP and in interpeak latencies I-III and III-V of BERA, the difference being significant statistically. Same results were found in many previous studies [7-13] in whom males were found to have significantly higher ($P > 0.05$) values than females. Also Lopez found the latencies of waves III and V and I – III and I – V intervals in BAEP were significantly shorter in women than in men in both ears [14].

Similarly, Kaneda Y *et al.* postulated that the sex differences in VEP may be attributed to genetically determined sex differences in neuroendocrinological systems [15]. Stockard *et al.* also suggested that they were due to sex differences in brain size [16, 17]. On the contrary, some studies showed no significant gender difference in latencies [18, 19].

The cause of lower values of BAEP and VEP latencies in females, as compared to males may be attributed to their smaller head size and higher body core temperature which leads to faster neuronal conduction in females [20-22]. It has also been proposed that female sex hormones (especially estrogen) have a favorable influence on the neuronal plasticity and, thereby resulting in decreased conduction time [23-26].

The present study also observed the effect of head circumference and BMI on different parameters of BAEP and VEP in young healthy adults. BAEP showed a positive correlation with head circumference but no correlation was observed with BMI. The head circumference reflects the brain size, hence the conduction time of neural pathway and thus considered

as independent AEP variable [27, 28]. While in another study with large sample size, it shows a poor correlation with head size [29]. BMI related findings were corroborative with a previous study by Solanki *et al.* [30, 31] but is not in accordance with other study where significant difference was observed [32].

In present study, VEP showed a significant positive correlation with BMI but no correlation was found with brain size. These findings are in corroboration with earlier studies [7] but in contrast to various studies which attributed these changes due to difference in geometry of head between males and females [11-15, 23].

Limitations of the study

In present study, influence of neuroendocrine factors on evoked potential studies was not taken into account. Another limitation might be the small sample size.

So, hormonal assay could be taken into account in future studies to look for the role of hormones as a cause of gender variation besides the anatomical differences.

CONCLUSION

There is a definite gender variation in BAEP and VEP parameters with BMI and head circumference and hence proved to be a variable affecting both the evoked potentials. So these variables should be taken into consideration while establishing a lab normative data and for clinical interpretation of evoked potential studies.

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