ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Normative Study of Brain Stem Auditory Evoked Potentials in Young Adults.

Shashiraj HK[1], Venkatesh G[1]*, and Vinutha Shankar MS[2].

[1]Assistant Professor, Sri Siddhartha Medical College, Tumkur, Karnataka, India.
[2] Professor, Sri Devaraj urs Medical College, Kolar, Karnataka, India.

ABSTRACT

Brain Stem Auditory Evoked Potentials (BAEP) are potentials recorded from ear and vertex in response to brief auditory stimulation to asses conduction through the auditory pathway upto the level of midbrain. BAEP comprises of five or more waves within ten milliseconds of the stimulus and three interpeak latencies. Each individual wave and interpeak latencies provides information about an area of auditory pathway starting with cochlear nerve to the level of inferior colliculi. Recently these potentials have been widely studied in audiology, neurology, neonatology and anaesthesiology. These potentials tend to vary with various ethnic groups. Since India has a widely diverse ethnic population, this study was undertaken to prepare normative data pertaining to local population and normalize the results with variables such as gender and anthropometric measures like head size which could have an effect on these recordings. In this randomized study, 100 normal subjects (50 males and 50 females) were selected. BAEP was recorded using EMG RMS PK II machine. Head measurements were taken with a measuring tape. The results were analyzed by descriptive methods. Males showed greater head measures and greater wave and interpeak latencies than female subjects with a significant p value of less than 0.001. All wave and interpeak latencies were greater in males than in females which could be because of bigger head size measurements in males.
Keywords: BAEP, Wave latencies and interpeak latencies, Head size

Corresponding author

INTRODUCTION

Brainstem Auditory evoked potentials are the potentials recorded from ear and vertex in response to brief auditory stimulation to assess conduction through auditory pathways up to the midbrain. BAEP comprises of five or more waves within ten milliseconds of the stimulus and three interpeak latencies. Each individual wave and interpeak latencies provides information about an area of auditory pathway starting with cochlear nerve to the level of inferior colliculi [1, 2].

BAEP waves are named named according to their sequence in roman letters from I to VII [3]. These waves represent their source of origin from auditory nerve (wave I), cochlear nuclei (wave II), superior olive (wave III) and lateral lemeniscus & inferior olivary nucleus (wave IV-V complex). Waves VI and VII are not found in all normal subjects. They are generated in medial geniculate body and auditory radiation from the thalamus to temporal cortex respectively [4]. The most constant and most important waves from the clinical point of view are waves I, III & V. [5]. Their measurements include absolute latency (stimulus to peak) and interpeak latency (time interval between the peaks). The clinical interpretation is based on the interpeak latencies (IPLs). The IPLs represent conduction time through these relay stations of auditory pathway in the brainstem. Thus IPL I-III is a measure of conduction from acoustic nerve to pontomedullary region, III-V conduction in the more rostral pontine and midbrain portion of the pathway and I-V reflects the total brainstem conduction time [6]. Absolute amplitudes are extremely variable in normal subjects [7].

These potentials depend on various physical variables such has gender and anthropometric variables like head size. So it becomes obligatory to compare wave and interpeak latencies with the above said variables to increase their clinical applicability [2].

Head size which is one of the important physical variable which actually reflects brain size is the basis of gender differences [8] and it is also a important source of inter subject variability which should be considered in order to increase the clinical usefulness of BAEP [9].

The aim of the study

To prepare normative database of BAEP and to assess gender variability and compare these parameters with anthropometric measures of head.

MATERIALS AND METHODS

The study was conducted at Sri Devaraj urs Medical college, Kolar. The Study group consisted of 100 normal healthy subjects (50 males and 50 females) who volunteered for the study and Institutional ethical clearance was obtained for the same. The subjects in the age group of 18-40 years with normal hearing were included in the study. Subjects with hearing impairment and with history of alcohol and substance abuse were excluded.

Methodology

BAEP was recorded from neurologically and audiologically normal adults in a electrically shielded room by using EMG RMS PK 2 machine. Surface electrodes were placed with two active electrodes placed over both the mastoid processes, with a reference electrode placed over vertex, and ground electrode over the forehead. One cycle of 4-kHz sinusoids at an intensity of 90 decibels was delivered through head-phones with alternating phase at interval stimulus of 75 ms. Signals were amplified and band-pass filtered from 3 to 100 khz. Signals were analysed with sampling intervals of 10 micro seconds and for 10.24 mili seconds after stimulus onset. After averaging 2000 sweeps the signals were digitally band-pass filtered. Peak latencies of waves were automatically detected with a time resolution of 0.01 mili seconds to minimize measuring errors.

Head size of the subjects was evaluated by measuring distances from nasion to inion(AP) and from ear to ear(RL) and head circumferences (HC) with a measuring tape.

Statistical Treatment of the data

Descriptive statistical analysis was carried out on this data. Results on continuous measurements are presented as Mean ± Standard deviation and results on categorical measurements are presented in number%. Significance was assessed at 5% level of significance. Percentile distribution of anthropometric parameters, wave latency and inter peak latencies were computed. BAEP recording was compared between males and females. The pearson correlation between anthropometric parameters, wave latency and inter peak latencies was also done with significance test by student's `t' test of significance of correlation. Regression analysis was carried out to find the significant predictors of anthropometric variables to predict the wave latency and inter peak latencies. Conclusions are drawn based on the outcome of this statistical treatment [12, 13].

RESULTS

Age distribution and gender: In this study 100 audiologically and neurologically normal subjects 50 each of males and females were selected. The average age of male subjects who constituted the study group was 18.84±0.51 years and average age of female subjects was 18.6±0.47 in years.

Table 1: Comparison of Anthropometric parameters between males and females

Anthropometric parameters	Male	Female	P value
Age in years	18.84±0.51	18.68±0.47	t=1.630;p=0.106
Ap in cms	35.60±1.04	30.08±3.78	t=8.589;p<0.001**
RL	21.16±1.41	18.04±0.87	t=13.309;p<0.001**
HC	56.52±1.30	53.59±2.20	t=8.116;p<0.001**

Table - 1 Head measurements that is AP (anterior to posterior) that is measurement from nasion to inion was taken. The measurement showed a mean value of 35.6 ±1.1 cms in males and 30.8±3.8 cms in females.

Another head measurement RL (Right to Left) that is measurement taken from ear to ear that is from mastoid to mastoid showed a mean value of 21.2±1.4cms in males and 18.1±0.9 in females.

The third measurement of Head i.e HC (Head Circumference) showed a mean value of 56.5 ±1.3cms in males and 53.6 ±2.2 in females respectively.

All the three measurements showed a significant difference between males and females with a significant 'p' value of less than 0.001.

Table - 2 Wave latencies and inter peak latency intervals

Wave I which is generated in the auditory nerve had a mean latency of 1.75±0.04 in males compared with mean of 1.69±0.05 in female subjects.

The second wave latency that is wave II which is generated in the cochlear nucleus showed a mean value of 2.84±0.04 in male subjects when compared with a value of 2.82±0.07 in females.

The wave III which originates in the superior olivary nucleus had a value of 3.91±.08 in males when compared with a value of 3.67±0.07 in females.

The wave IV which originates in the lateral lemniscus had value of 5.14±0.08 in males when compared with a value of 4.87 ±0.05 in female subjects.

Similarly wave V which originates in inferior colliculi latency was 5.71±0.09 in males when compared with a value of 5.37±0.07 in a equal number of female subjects.

Inter peak latencies which are I-III, I-IV and III-IV. I-III IPL which is a measure of conduction from proximal eighth nerve across subarachnoid space into the core of lower pons showed a mean value of 2.12±0.05 in males when compared with a value of 1.92±0.05 in female subjects. The other clinically relevant I-V IPL which is a measure of conduction from proximal eighth nerve through pons to midbrain had mean latency of 4.17±0.07 in males when compared with a value of 3.89±0.04 in female subjects. The last IPL of importance is III-V which indicates conduction from lower pons to midbrain had a mean value of 1.91±0.04 in males when compared with a value of 1.76±0.05 in a similar number of female subjects that is fifty. These figures have been graphically represented as well under table 2.

According to **table 2** wave latencies and IPL has been compared between males and females and application of student t test revealed a significant difference in latencies with a p value of less than 0.001 for all variables except wave II which showed significance with a p value which was equal to 0.013.

Most researchers have given enough experimental evidence that wave II is poorly formed in most recordings.

Figure 1: Comparison of Anthropometric parameters between males and females

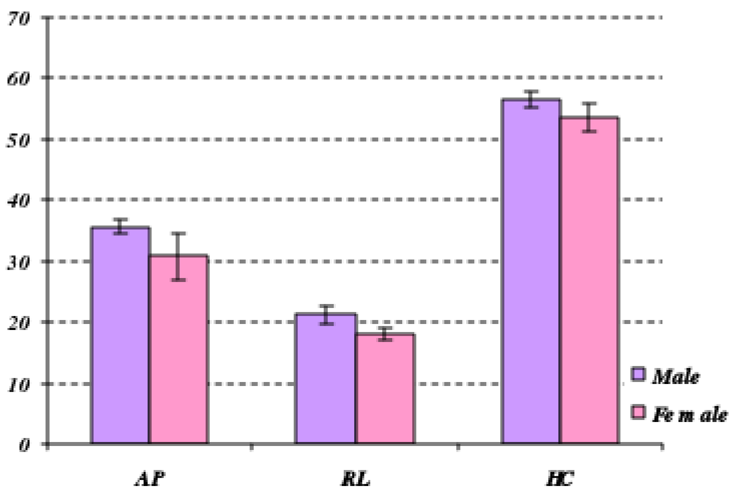

Table 2: Comparison of Wave latency and IPL between males and females

Wave latency and IPL in milliseconds	Male	Female	P value
Wave I	1.75±0.04	1.69±0.05	t=6.799;p<0.001**
Wave II	2.84±0.04	2.82±0.07	t=2.52;p=0.013*
Wave III	3.91±0.08	3.67±0.07	t=15.948;p<0.001**
Wave IV	5.14±0.08	4.87±0.05	t=20.834; p<0.001**
Wave V	5.71±0.1	5.37±0.07	t=20.932; p<0.001**
IPL I-III	2.11±0.05	1.92±0.05	t=19.235; p<0.001**
IPL III-V	1.91±0.04	1.76±0.05	t=17.803; p<0.001**
IPL I-V	4.17±0.07	3.89±0.04	t=24.477; p<0.001**

From all these observations it can be concluded that there is statistically significant difference between males and females in all wave latencies and IPL.

Table - 3 Pearson co-relation of anthropometric parameters with wave latency and IPL:

When wave latencies and IPL were correlated with head size in both males and females in table 5 there was a significant correlation for all measures except for RL measurement.

In Tables 4 & 5 regression analysis using the anthropometric variables as predictors for wave latency and IPL in males as well as for females has been done which also showed a strong correlation between wave and IPL versus head size.

Figure 2 : Comparison of Wave latency and IPL between males and females

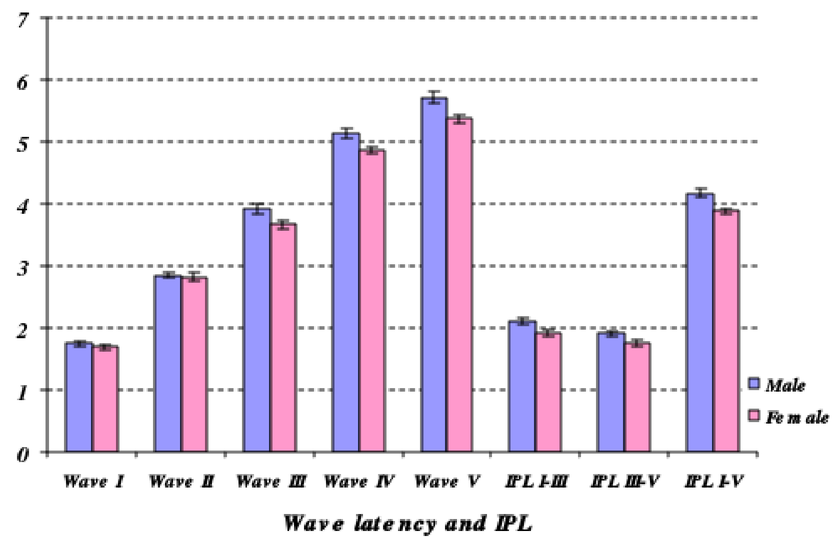

Table 3: Pearson correlation of anthropometric parameters with Wave latency and IPL

Wave latency and IPL in milliseconds	Wave I	Wave II	Wave III	Wave IV	Wave V	IPLI-III	IPL III-V	IPL I-V
MALE								
AP	0.773**	0.652**	0.616**	0.558**	0.620**	0.562**	0.578**	0.441**
RL	0.465**	0.473**	0.456**	0.499**	0.518**	0.594**	0.358*	-0.095
HC	0.541**	0.465**	0.387**	0.371**	0.404**	0.384**	0.422**	0.281*
FEMALE								
AP	0.662**	0.098	0.950**	0.567**	0.633**	0.002	0.505**	0.747**
RL	0.116	-0.055	0.170	0.122	0.170	0.273*	0.220	0.323*
HC	0.700**	0.155	0.602**	0.551**	0.636**	-0.053	0.364**	0.798**
All subjects								
AP	0.770**	0.284**	0.767**	0.729**	0.748**	0.622**	0.750**	0.731**
RL	0.591**	0.295**	0.794**	0.825**	0.831**	0.843**	0.781**	0.745**
HC	0.774**	0.329**	0.736**	0.711**	0.732**	0.603**	0.697	0.716**
Head size								
Male	0.796**	0.717**	0.657**	0.650**	0.699**	0.707**	0.609**	0.254+
Female	0.668**	0.107	0.634**	0.559**	0.636**	0.017	0.468**	0.784**
All subjects	0.798**	0.329**	0.839**	0.820**	0.838**	0.736**	0.815**	0.802**

Table 4: Regression analysis using the anthropometric variables as predictors for Wave Latency and IPL in male subjects (n=50)

Wave latency and IPL in milliseconds	Regression co-efficient/P value	AP in cms	RL in cms	HC in cms	Constant	R^2
Wave I	Regression coefficient	0.020	0.007	0.005	0.578	69.9
	P value	<0.001**	0.002**	0.038*	-	-
Wave II	Regression coefficient	0.017	0.009	0.005	1.727	54.5
	P value	<0.001**	0.003**	0.123	-	-
Wave III	Regression coefficient	0.038	0.019	0.006	1.797	47.9
	P value	<0.001**	0.006**	0.418	-	-
Wave IV	Regression coefficient	0.029	0.021	0.007	3.264	45.4
	P value	0.004**	0.002**	0.347	-	-
Wave V	Regression coefficient	0.042	0.026	0.009	3.169	52.9
	P value	<0.001**	0.001**	0.309	-	-
IPL I-III	Regression coefficient	0.018	0.018	0.005	0.790	54.3
	P value	0.004**	<0.001**	0.249	-	-
IPL III-V	Regression coefficient	0.015	0.006	0.005	1.012	40.2
	P value	0.003**	0.068+	0.199	-	-
IPL I-V	Regression coefficient	0.032	-0.012	0.004	3.047	24.7
	P value	0.004**	0.093	0.627		

Table 5: Regression analysis using the anthropometric variables as predictors for Wave Latency and IPL in Female subjects (n=50)

Wave latency and IPL in milliseconds	Regression co-efficient/P value	AP (in cms)	RL (in cms)	HC (in cms)	Constant	R^2
Wave I	Regression coefficient	0.002	-0.009	0.014	1.036	51.7
	P value	0.501	0.148	0.014*	-	-
Wave II	Regression coefficient	-0.004	-0.011	0.013	2.433	4.8
	P value	0.496	0.401	0.232	-	-
Wave III	Regression coefficient	0.010	-0.004	0.004	3.231	42.6
	P value	0.033*	0.656	0.668	-	-
Wave IV	Regression coefficient	0.005	-0.005	0.006	4.502	33.7
	P value	0.186	0.490	0.379	-	-
Wave V	Regression coefficient	0.008	-0.005	0.011	4.688	42.8
	P value	0.221	0.561	0.159	-	-
IPL I-III	Regression coefficient	0.004	0.018	-0.010	2.012	12.5
	P value	0.313	0.024*	0.143	-	-
IPL III-V	Regression coefficient	0.012	0.006	-0.012	1.901	30.9
	P value	0.002**	0.415	0.074+	-	-
IPL I-V	Regression coefficient	0.001	0.002	0.011	3.219	64.2
	P value	0.466	0.709	0.003**	-	-

DISCUSSION

Recently BAEP recordings are used widely in audiology, neurology, neonatology and anaesthesiology. The key in making diagnosis in these branches of medicine involves analysis of the component wave latencies and inter peak latencies of the BAEP. [1] The absolute latencies and inter peak latencies are often compared to existing normative values in making diagnostic decisions. A number of subject factors have been shown to affect these normal latency values. One factor which has been shown to be related to BAEP latencies is gender.[10] Female adults exhibit shorter absolute and inter wave latencies than their male counterparts. Studies done earlier have demonstrated these gender differences. [8]

On basis of these experimental evidences different norms have been identified for female versus male subjects. A precise explanation for these gender differences needs to be established.

Several researchers have suggested these differences in central conduction time between male and female subjects are due to differences in growth in central nervous system and actual brain size. [2]

In addition evidence given by a study done earlier suggests that central conduction time along the auditory pathway can be predicted from measures of skull diameter.

Study done by Dennis R. Trune showed that head diameter, correlated more highly with BAEP waves than did gender.[10]

The variations found in the BAEP wave forms and interpeak latencies support the possible role of gender as a contributive factor for normal variations. [11]

In this present study, BAEP were recorded in subjects belonging to local ethnic population from male and female subjects with varying head sizes. It was hypothesized that head size would prove to be an accurate reflector of brain size and the resultant central conduction time.

The following conclusions can be drawn at the end of the study:

- Male subjects included in this study were found to have bigger head measures that is AP (nasion to inion), RL (mastoid to mastoid) and HC (head circumference) than female subjects with a significant difference of p value of <0.001.
- All wave latencies that is I, II, III, IV, V and inter peak latencies like I-III, I-V and IIIV were significantly higher in males than in females with a p value of <0.001.
- Head measures positively correlated with all wave and inter peak latencies in all subjects demonstrating that BAEP of both genders are sensitive to head size changes.
- The gender differences seen in wave latencies and inter peak latencies could be because of greater head size in males than females.

BAEP has a wide range of clinical applications. As technology continues to evolve BAEP will likely provide more qualitative and quantitative information regarding the function of the auditory nerve and brainstem pathways.

ACKNOWLEDGEMENT

Dr Pradeep Mitra Dr S.S Mishra Dr Karthiyani kutty. Sri Devaraj urs Medical College, Kolar

REFERENCES

[1] Misra UK and Kalita J. Clinical Neurophysiology. In: second edition, Delhi Elsevier, 2008:329-345.
[2] Keith A. Chiappa. Evoked potentials in clinical medicine, third edition, New York: Lippin Cott-Raven, 1997:157-249
[3] Rosenhall U, Bjorkman G, Pederson K and Kall A. Electroenceph Clin Neurophysiol 1985; 62:426-430.
[4] Starr A, Allen A and Don M. Ann Otol 1976; 86:186-195.
[5] Chiappa KH. Evoked potential in clinical medicine. Edited by K H Chiappa and Con Yiannikas Raven press. New York 1983 (Ist Edition).
[6] Rozhkov VP and Soroko SI. Human Physiol 2009; 35 (6): 703-713
[7] Poon's M. Shrine Neurol 2003;14:1-3
[8] Aoyagi M, Kim Y, Yokoyamo J, Kiren T, Suzuki Y, Oike Y. Audiol 1990; 29:107-112.
[9] Dempsey JJ, Censoprano E, Mazor M. Audiol 1986 ; 25:258-262.
[10] Trune DR , Mitchell C , Phillips DS. Hearing Res 1988; 32:165-174.
[11] Khatoon M, Nighute S and Ishaque M. JRAAS 2013; 28:113-117
[12] Venkataswamy M. NIMHANS publication. 2002; 108-144.
[13] Sunder Rao PSS, Richard J. An introduction to biostatistics, a manual for students in health sciences, New Delhi: Prentice hall of India 86-160.