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ORIGINAL ARTICLE

AGE AND GENDER RELATED DIFFERENCES IN BRAINSTEM AUDITORY EVOKED POTENTIALS (BAEPS) IN ADULTS WITH NORMAL HEARING

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ABSTRACT:

Background: Brainstem auditory evoked potential (BAEP) is an important neuro-electro dignostic test for evaluation of auditory pathway from inner ear through auditory nerve to the cortex. BAEPs are used to evaluate the integrity of auditory pathways and to localize defective transmission in clinical practice. Age and gender may alter various components of BAEP waves and can be important factors in clinical interpretation of BAEP results. So the present study was conducted to investigate possible effects of age and gender differences in BAEP latencies, interpeak latencies and amplitudes in different age groups of both sexes. **Materials & Methods**: A total number of 100 healthy normal hearing subjects (50 males and 50 females) aged 15-50 years were selected and were further subdivided into 4 equal groups of 25 each. The absolute peak latencies, interpeak latencies and amplitudes of BAEP waves in various age groups as well as both sexes were analyzed. The data was collected from both ears and was analysed statistically. **Results:** A significant increase in peak latency, interpeak latency and decrease in amplitude values of all waves was found with increase in age. Also a significant increase in all these parameters was observed in males as compared to females. **Conclusion:** All the changes in BAEPs waves in our study support the possible role of age and gender as contributory factors for normal variations which should be considered while interpreting the results of BAEP in clinical practice.

Key words: Brain stem auditory evoked potentials, age, gender.

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INTRODUCTION

Brain stem auditory evoked potentials (BAEPs) are the summation of electrical fields generated through synaptic discharges and postsynaptic potentials of auditory nerve pathways from hair cells of organ of Corti up to cerebral cortex. The electrical activity is recorded from scalp following a brief acoustic stimulus, occurring within 10ms of application of stimulus. BAEPs consist of a series of five or more positive waves (I to VII) resulting from neuro-electrical activity generated by specific structure in auditory pathway.

Waves generated in auditory pathway are from: proximal auditory nerve (wave I), cochlear nuclei (wave II), superior olivary nucleus (wave III), lateral lemeniscus & inferior colliculus (wave IV-V complex), medial geniculate body (wave VI) and auditory radiation from the thalamus to temporal cortex (wave VII). Waves VI and VII are usually absent in all normal subjects. Waves are measured in terms of their absolute latencies, interpeak latencies (IPLs) and absolute amplitudes. Interpeak latencies (IPLs) include conduction from acoustic nerve to ponto-medullary region (I-III), conduction lower pons to upper pontine and midbrain portion of the pathway (III-V) and total brainstem conduction time(I-V).[1] Absolute amplitudes of BAEP peaks are extremely variable in normal subjects. So V/I ratio is considered to decrease intersubject variability.[2]

BAEP waves especially peak latencies, are clinically useful in diagnosing hearing disorders, brainstem lesions, demyelinating diseases and dementia due to their stability and reproducibility.[3] The test can assess both peripheral and central components of the auditory functions. However, the clinical application of the test largely depends on the normal values adjusted for the various confounding variables in normal healthy subjects.

BAEP waves are known to be influenced by some recording variables (electrodes, filters), stimulus variables (stimulus intensity, stimulus rate, stimulus mode, stimulus phase) and also subject variables (age,

gender, body temperature, hormonal status, hearing status).[4,5]

Peak latencies and inter peak latencies (IPLs) of BAEP are found to be affected by aging.[6] Below 2 years of age, interpeak latencies are prolonged as compared to those in adults. By the age of 2 years, their values reach the adult levels which may be due to progressive myelination of the auditory pathway.[7,8] The latencies of waves I, III, and V increased by 0.1 to 0.2 ms with increasing age.[9] Interpeak latencies (IPLs) of the waves I-III, III-V and III-V were also found to be more in the older age groups relative to that in young people [5]. Prolongation of latencies and interpeak latencies of BAEP waves with aging suggests the slowing of processing in auditory system with aging.

BAEP is seen to be affected by other factors as gender and head size. It was seen that males have longer latencies of the waves III and V by about 0.1 to 0.2 ms and also longer I–V interpeak intervals than females which could be related to larger head size or larger size of the external acoustic meatus.[10]

Aging and gender can be important source of variations in various subjects, so these factors should be considered to increase the clinical usefulness of BAEP. So it becomes obligatory to compare wave latencies and interpeak latencies with the above said subject variables to increase their clinical applicability. Hence the present study was undertaken to analyze the effect of age and gender on BAEP waves in audiologically normal subjects of both sexes.

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology at Guru Gobind Singh Medical College, Faridkot. The protocol of the study was approved by the Institutional Ethics Committee. All the subjects gave their written informed consent after the nature of the experiment had been fully explained.

Study design

The present study was conducted on 100 normal healthy volunteers (69 women and 31 men) aged 15-50 years with no clinical evidence of hearing disorder. They were further divided according to their age as follows:

Group 1: 15-25 years (n=25)
Group 2: 26-35 years (n=25)
Group 3: 36-45 years (n=25)
Group 4: 46-50 years (n=25)

Inclusion criteria

1. Apparently healthy subjects with normal hearing.
2. No past/present history of any ear disease or deafness.

Exclusion criteria

Subjects with a history of any ear problem such as discharge, hearing loss, ear surgery, ototoxic medication, or any systemic disease that affects hearing were excluded from the study. Subjects with history of substance abuse and alcohol and those suffering from any disease known to affect the study such as diabetes mellitus, epilepsy, hypertension, brain damage or hormonal imbalance such as acromegaly were excluded from the study. Diseases were excluded by taking their history, general physical examination and audiological examination.

The recording procedure: Brain stem auditory evoked potentials (BAEPs) was recorded in a shielded room by using Digital data acquisition and analysis system model Neurostim (NS4) by Medicaid systems, Chandigarh, India.

The subjects were asked to sit comfortably in a fully relaxed state and were instructed not to sleep during the procedure.

Three disc electrodes were placed (10-20 international system of electrode placement) as follows

i. Ground electrode: At the forehead in the midline.
ii. Active electrode: At the mastoid process ipsilateral to the acoustic stimuli.
iii. Reference electrode: At the vertex of the skull.

Both the ears of all the subjects were tested (one ear at a time). The contralateral ear was always masked with white noise 40dB below the ipsilateral click stimuli in order to get a correct response. Procedure was done twice in each subject.

Brief click acoustic stimuli (square wave pulse of 0.1ms duration) alternating in polarity were given by an earphone to the ear with 40 and 70 dB intensities. With a filter setting of 100 Hz (low filter) to 3000 Hz (high filter), 2000 sweeps were averaged. Sensitivity was set at 0.5μv/ div and sweep speed was 1ms/div. Skin to electrode impedance was kept below 5kohm.

Peak BAEP latencies (I, II, III, IV and V), interpeak latencies (I-III, III-V and I-V) and amplitudes (I-Ia, V-Va) of waves were measured. The results were expressed as mean ± SD. BAEP waves latencies, interpeak latencies and amplitudes of different groups according to age and gender, were compared and analysed statistically.

STATISTICAL ANALYSIS

The effect of age in different age groups was compared and analyzed using one-way ANOVA using SPSS software version 16.0. The effect of gender was obtained by unpaired t-test. p value less than 0.05 was considered as statistically significant.

RESULTS

Tables 1and 2 show the results of the statistical analysis and the mean ± SD of latencies, interpeak latencies and amplitudes of BAEP waves of different age groups in right and left ears respectively. Table 3 shows the comparison of mean ± SD of latencies, interpeak latencies and amplitudes of BAEP waves of right and left ears in males and females.

Table I: Comparison of latencies, interpeak latencies and amplitudes of ABR waves in right ear

BAEP Waves	Group 1 (n=25)	Group 2 (n=25)	Group 3 (n=25)	Group 4 (n=25)	F value	p value
I(msec)	1.22±0.33	1.26±0.39	1.35±0.36	1.50±0.38	2.88	0.03*
III(msec)	3.24±0.34	3.20±0.39	3.45±0.49	3.54±0.51	3.49	0.01*
V(msec)	5.21±0.25	5.22±0.41	5.38±0.31	5.47±0.49	2.83	0.04*
I-III(msec)	2.11±0.41	2.09±0.45	2.36±0.47	2.39±0.59	2.70	0.04*
I-V(msec)	3.84±0.45	3.91±0.51	4.16±0.54	4.24±0.61	3.29	0.02*
III-V(msec)	1.76±0.43	1.76±0.38	1.98±0.48	2.04±0.37	3.07	0.03*

*p<0.05- significant

Table II: Comparison of latencies, interpeak latencies and amplitudes of ABR waves in left ear

BAEP Waves	Group1 (n=25)	Group 2 (n=25)	Group 3 (n=25)	Group 4 (n=25)	F value	p value
I(msec)	1.22±0.21	1.25±0.39	1.33±0.30	1.47±0.40	2.79	0.04*
III(msec)	3.36±0.48	3.47±0.30	3.58±0.32	3.68±0.31	3.67	0.01*
V(msec)	5.24±0.32	5.32±0.28	5.46±0.40	5.54±0.31	4.18	0.007
I-III(msec)	2.18±0.41	2.19±0.44	2.30±0.21	2.48±0.34	3.72	0.01*
I-V(msec)	3.73±0.45	3.95±0.54	4.12±0.47	4.21±0.50	4.62	0.004*
III-V(msec)	1.70±0.53	1.72±0.35	1.90±0.36	1.99±0.42	2.79	0.04*

*p<0.05- significant

Table III: Comparison of mean ± SD of latencies, interpeak latencies and amplitudes of BAEP waves of right and left ears in males and females.

Waves	Right ear			Left ear		
	Males (n=50)	Females (n=50)	p Value	Males (n=50)	Females (n=50)	p Value
I(msec)	1.36±0.43	1.20±0.32	0.03*	1.35±0.36	1.21±0.34	0.04*
III(msec)	3.39±0.38	3.23±0.31	0.02*	3.38±0.47	3.21±0.36	0.04*
V(msec)	5.20±0.41	5.02±0.22	0.007*	5.27±0.47	5.08±0.39	0.03*
I-III(msec)	2.29±0.42	2.11±0.26	0.01*	2.34±0.29	2.13±0.54	0.01*
I-V(msec)	3.93±0.51	3.68±0.43	0.009*	3.96±0.48	3.67±0.54	0.005*
III-V(msec)	1.76±0.33	1.64±0.25	0.04*	1.82±0.31	1.65±0.45	0.03*

*p<0.05- significant

DISCUSSION

BAEP is used widely in audiology, neurology, neonatology and anaesthesiology to evaluate integrity of brainstem nuclei and peripheral auditory pathways.[1] The present study revealed that there was significant increase in the peak latencies and interpeak latencies of all waves with age as well as in males.

As far as age is concerned, our findings are similar to findings of some authors in terms of peak latencies[5,11,12,13] and all interpeak latencies[5,11,12] of BAEP waves while only I-III interpeak latency was increased in others.[13] However, in some studies with normal hearing subject, no age related changes in BAEP absolute latencies[14,15] and interpeak latencies[15,16] was found. In another study, prolonged wave I latency and without any difference in interpeak latency (represents central conduction time through the auditory pathways), suggested changes in peripheral auditory structures only[16,17,18]. It was thus concluded that aging is essentially a peripheral phenomenon and does not involve central part of the acoustic pathway[15,17,18] not at least up to the region of the superior olivary complex and inferior colliculi.[18] Also, a decrease in amplitude of waves was found in elderly subjects in our study and is consistent with findings of other authors.[18]

The increased latency and the interpeak latency observed in elderly subjects could be due to degenerative changes as auditory nerve atrophy, synaptic delay and peripheral hearing loss with age. Structural changes in the auditory nerve and retrocochlear cell degeneration lead to loss of synchrony of auditory pathways.[18,19] Increasing age also causes neuronal loss and changes in the permeability of neural membrane, which may lead to increased latencies of BAEPs.[19] Primary degeneration of the spiral ganglion cells or loss of nerve cells and fibers can occur even in absence of loss of sensory hair cells that was found to be age related.[20,21] Apart from neuronal loss, other degenerative changes as cellular atrophy and ghost like indistinct shape of cell body, accumulation of lipofuscin pigments have been observed in the superior olivary nucleus, inferior colliculus, cochlear nucleus, medial geniculate body, and inferior olive[22,23] which suggests that aging also involves central auditory pathway.

Degenerative changes in the myelin sheaths and axis cylinders have also been reported.[23] A relation between age and decrease in volume of cochlear nucleus was seen that appeared to be associated with changes in axon size and degree of myelination.[24]

Prolongation of latency of BAEP waves with aging may also be related to cognitive decline in elderly. Altered cognition during aging has been found to be caused by the deterioration of GABA, cholinergic and dopaminergic systems. There is a decrease in number of mascarinic Ach receptors in CNS as well as activity of

choline acetyltransferase in the nerve terminals with aging. On the other hand, nigrostriatal axons, nigrostriatal dopaminergic neurons, strial endogenous dopaminergic concentration in human brain and D2 dopamine receptor binding sites were found to decrease with age.[25]

Also there occurred significantly increased latencies of the waves I, III & V and interpeak latencies of the waves, I-III and I-V in males as compared to females, thus showing that gender affects these waves. Our findings are consistent with other findings also.[9,10,14,26]

Differences in conduction time in auditory pathway between male and female subjects may be due to differences in growth in head size and hence actual brain size.[10] Thus, it was suggested that conduction time along the auditory pathway can be predicted from measurement of skull diameter. Females exhibit shorter corresponding segments of auditory pathways. Head diameter, due to differences in relative distances of the anatomical generators, was found to be associated more with BAEP waves than did gender.[9]

Apart from head size, reduction of wave latencies and interpeak latencies in females than in males could be due to differences in the hormones and core body temperature.[27]

The hormones after puberty may influence the conduction velocity of nerve impulses & release of neurotransmitter at synapses. Acetylcholine (Ach) can be one of the neurotransmitters in auditory pathway and there can be interaction between estrogen and Ach for improvement of auditory transmission.[28,29] Female sex hormones (especially estrogen) have a favorable influence on the metabolic levels of neurotransmitters, thereby resulting in faster neuronal conduction time in the auditory pathway. In post-menopausal women, neuronal transmission was decreased in females due to fall in levels of circulating estrogen levels, resulting in increase in the BAEP latencies of females.[30] Significant improvement in neuronal transmission in terms of significant reduction in various BAEP waveform latencies was observed after 6 months of hormonal replacement therapy among post-menopausal women.[31]

CONCLISION: Significant variations in the BAEPs in our study support the possible role of age and gender to be contributing factors for normal variations. BAEP is non invasive measures of the functional integrity of subcortical auditory pathways and its wave latencies and interpeak latencies have important diagnostic values in clinical practice. So, we recommend that subject variations should be taken into consideration while interpreting the results of BAEP in various diseases

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