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RESEARCH ARTICLE

Study of brainstem auditory evoked potentials in normal healthy persons

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ABSTRACT

Background: Auditory evoked potentials (AEPs) are very small electrical voltage potentials signal generated by a sound through the auditory pathway. Age and gender influence on the brainstem AEPs (BAEPs) deserve keen appraisal for correct clinical application and inference. **Aims and Objective:** The aims and objectives of the study are to get the normal range of latencies and amplitude of waveforms of BAEP in healthy normal person. **Materials and Methods:** BAEPs from either ear of normal hearing 150 men and 145 women in 1-73 years age range were studied. Absolute peak latencies of Waves I-V were examined in reference to the influence of age and gender. **Result:** The latencies of Waves I value are significantly higher in males in 25-34 years and 35-44 years age groups than in females. In both genders, Waves II value is higher in ≥45 years age groups. The latencies of Waves III value are significantly higher in males in all age groups except in 35-44 years age groups than in females. In males, Waves I value is higher in ≥45 years age groups while in females Waves III value is higher in 35-44 years age groups. The latencies of Waves IV value are significantly higher in males in all age groups except in 15-24 years age groups and ≥45 years age groups than in females. The latencies of Waves V value are significantly higher in males in all age groups except in 35-44 years age groups and ≥45 years age groups than in females. **Conclusion:** Significant changes in the BAEPs in our study support the possible role of age and gender as contributively factors for normal variations.

KEY WORDS: Brainstem Auditory Evoked Potentials; Auditory Pathway; Hearing; Healthy Person

INTRODUCTION

Evoked potential refers to surface electrical activity recorded from the surface of the scalp in response to a specific and adequate stimulus - Auditory, visual, and somatosensory.[1] Auditory evoked potentials (AEPs) are very small electrical voltage potentials signal generated by a sound through the auditory pathway. The evoked potential is generated in the cochlea, goes through the cochlear nerve, through the cochlear nucleus, superior olivary complex, lateral lemniscus, to the inferior colliculus in the midbrain, on to the medial geniculate body, and finally to the auditory cortex.

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Brainstem AEP (BAEP) is a simple, objective and non-invasive method of hearing pathway evaluation. It allows the neurophysiological analysis of auditory pathway from the inner ear to auditory cortex. It assesses hearing in uncooperative patients and very young children whose hearing cannot be tested behaviorally. It is used for newborn hearing screening, auditory threshold estimation, determining hearing loss type, intraoperative monitoring.

Recently, BAEP is a diagnostic technique in audiology, neurology, pediatric.[2-4] BAEPs consist of a series of five positive waves occurring within 10 ms, following the acoustic stimulus and are labeled I-V in Roman. The waves depict neuroelectrical activity generated sequentially by structures in auditory neural pathway.

The useful clinical information in BAEP resides in the latencies and amplitude of waveforms. These potentials depend on various physiological variables such as age, gender, head size, and anthropometric variables. Therefore, to elucidate the significance of BAEP in diagnosis, the first step in interpretation requires the identification of the waveforms of BAEP.

Thus, this study is undertaken to get normal range of latencies and amplitude of waveforms of BAEP in healthy normal person.

MATERIALS AND METHODS

This study was conducted at Electrophysiology Laboratory in Physiology Department of Government Medical College, Bhavnagar, Gujarat, between January 2012 and January 2014. The study protocol was examined and approved by the Institutional Ethical Committee. Over the period, subjects were recruited as volunteers from hospital staff and accomplices of the in-patients. They were thoroughly clinically examined, including otoscopy to exclude chronic ear and other diseases or any continuing medications for chronic diseases. Blood pressure was taken to exclude hypertensive, blood random sugar estimation and urea profiles were requisitioned, and diabetes and renal dysfunction were ruled out.

Subjects were elaborately explained about the test procedures and study objective. After their informed consent was obtained they became study subjects. No disclosure of their identity without their concurrence was assured. Participants were hearing screened on pure tone audiometric test. Only those with hearing threshold equal to or below 20 dB at routine frequencies were included. In all, 295 subjects 150 men and 145 women participants were finally included in the study. They were in age range of 1-73 years.

The BAEP Study

The BAEP recording room was quiet and air-conditioned with temperature about 28°C. Electrode application followed 10/20 system of electrode placement with one channel setting. Silver chloride cup electrodes were attached on each ear lobule (A1/A2); at the vertex (Cz), as the reference electrode in 10/20 electrode placement system, and on the forehead (G), as the ground electrode. The site of application was cleaned with spirit. Conductive paste was applied to electrode and placed on prepared site. Recording was done using RMS EMG EP Mark 2 machine (RMS Recorders and Machine Systems, Chandigarh, India).

Stimulation

Alternate clicks at repetition rate of 11.1/s were presented mono-aurally through earphone. Intensity of stimulus was 90 dB. For each record, computerized averaging was done. Each ear was separately tested. Two trials were given in each subject. Peak latencies were measured for each ear, from the leading edge of the driving pulse to positive peaks. Peak amplitude was measured from the pre-stimulus baseline. The latencies of Waves I-V were selectively measured. Waves VI and VII were not clearly defined with the apparatus system. Thus, collected data were analyzed using Microsoft Excel Software (Trial Version). Student's *t*-test and one-way ANNOVA test were applied.

RESULTS

The latencies of Waves I value is significantly higher in males in 25-34 years and 35-44 years age groups than in females. In both genders, Waves I value is higher in ≥45 years age groups (Table 1). The latencies of Waves II value are higher in males in all age groups than in females. In both genders, Waves II value is higher in ≥45 years age groups (Table 2).

The latencies of Waves III value are significantly higher in males in all age groups except in 35-44 years age groups than in females. In males, Waves I value is higher in ≥45 years age groups, while in females, Waves III value is higher in 35-44 years age groups (Table 3). The latencies of Waves IV value are significantly higher in males in all age groups except in 15-24 years age groups and ≥45 years age groups than in females. In both genders, Waves IV value is higher in ≥45 years age groups (Table 4). The latencies of Waves V value are significantly higher in males in all age groups except in 35-44 years age groups and ≥45 years age groups than in females. In both genders, Waves IV value is higher in ≥45 years age groups (Table 5).

DISCUSSION

BAEP is a simple, objective, informative, and non-invasive method of hearing pathway evaluation. BAEPs are the evoked potentials which are recorded in response to an auditory stimulus from electrodes placed on the scalp. They reflect neuronal activity in the auditory nerve pathway. The BAEP has become a useful in audiology, neurology, neonatology.

In our study, the latencies of Waves I value are significantly higher in males in 25-34 years and 35-44 years age groups than in females. In both genders, Waves I value is higher in ≥45 years age groups. Rowe,[5] Harkins [6] Rosenhall et al.,[7] Costa et al.,[8] Mohammad et al.,[9] and Oku and Hasegewa[10]

Table 1: Wave I latency value (mean±SD values) comparison between various age groups

Age groups (years)	Male	Female	*P* value
1-14	1.59±0.13	1.55±0.13	0.2711
15-24	1.65±0.16	1.61±0.14	0.3483
25-34	1.73±0.16	1.62±0.19	0.0462
35-44	1.74±0.17	1.66±0.19	0.0287
≥45	1.83±0.13	1.77±0.18	0.3475

SD: Standard deviation

Table 2: Wave II latency value (mean±SD values) comparison between various age groups

Age groups (years)	Male	Female	*P* value
1-14	2.54±0.21	2.62±0.10	0.0914
15-24	2.64±0.14	2.56±0.27	0.1146
25-34	2.64±0.19	2.56±0.23	0.1030
35-44	2.74±0.17	2.70±0.18	0.3227
≥45	2.78±0.17	2.80±0.15	0.3118

SD: Standard deviation

Table 3: Wave III latency value (mean±SD values) comparison between various age groups

Age groups (years)	Male	Female	*P* value
1-14	3.76±0.14	3.67±0.17	0.0234
15-24	3.70±0.17	3.57±0.16	0.0029
25-34	3.73±0.17	3.59±0.23	0.0105
35-44	3.81±0.15	3.77±0.23	0.3380
≥45	3.86±0.12	3.71±0.31	0.0211

SD: Standard deviation

Table 4: Wave IV latency value (mean±SD values) comparison between various age groups

Age groups (years)	Male	Female	*P* value
1-14	4.81±0.17	4.69±0.21	0.0177
15-24	4.82±0.13	4.77±0.20	0.1521
25-34	4.82±0.13	4.66±0.29	0.0080
35-44	4.90±0.12	4.75±0.26	0.0040
≥45	4.93±0.24	4.84±0.20	0.0611

SD: Standard deviation

Table 5: Wave V latency value (mean±SD values) comparison between various age groups

Age groups	Male	Female	*P* value
1-14	5.63±0.26	5.48±0.21	0.0142
15-24	5.68±0.20	5.55±0.26	0.0227
25-34	5.70±0.23	5.50±0.48	0.0421
35-44	5.63±0.23	5.55±0.16	0.1429
≥45	5.75±0.24	5.65±0.44	0.2137

SD: Standard deviation

found latencies of Wave I were progressively delay in the older participants due to peripheral processes. Dass et al.,[11] Trune et al.,[12] Manjuran and Arora,[13] and Chu[14] showed that females have shorter latency for Wave I compared with that of males.

In our study, the latencies of Waves II value is higher in males in all age groups than in females, but the difference was insignificant. In both genders, Waves II value is higher in ≥45 years age groups. Harinder et al.[1] and Aoyagi et al.[15] had observed no significant gender difference for Wave II. Manjuran and Arora,[13] Chu,[14] and Jatiya et al.[16] showed that the peak latency of Wave II was significantly longer in males as compared to females. Patterson et al.[17] studied age and sex differences in the human. They found age effects for Waves II. Harinder et al.[1] and Khatoon et al.[18] found no significant difference for Wave II in older adult compared to young adult.

In our study, the latencies of Waves III value are significantly higher in males in all age groups except in 35-44 years age groups than in females. In males, Waves I value is higher in ≥45 years age groups, while in females, Waves III value is higher in 35-44 years age groups. Mohammad et al.,[9] Harinder et al.,[1] and Khatoon et al.[18] showed that the older adults had prolonged Wave III latencies. Rosenhall et al.,[7] Oku and Hasegewa,[10] Trune et al.,[12] Johannsen and Lehn[19] reported that older adults had increased latency for Wave III. Trune et al.,[12] Manjuran and Arora,[13] Chu,[14] Harinder et al.,[1] Aoyagi et al.,[15] Jatiya et al.,[16] Khatoon et al.,[18] and Kjaer[20] showed that the peak latency of Wave III was significantly longer in males as compared to females.

In our study, the latencies of Waves IV value is significantly higher in males in all age groups except in 15-24 years age groups and ≥45 years age groups than in females. In both genders, Waves IV value is higher in ≥45 years age groups. Harinder et al.[1] reported that no significant differences were found for Wave IV between younger males and older males while the latency of Wave IV showed an increasing trend with age in female. Johannsen and Lehn[19] observed that significant long latency in older subjects for Wave IV. Chu,[14] Jatiya et al.,[16] and Kjaer[20] found that the peak latency of Wave IV was significantly longer in males as compared to females.

In our study, the latencies of Waves V value is significantly higher in males in all age groups except in 35-44 years age groups and ≥45 years age groups than in females. In both genders, Waves IV value is higher in ≥45 years age groups. Costa et al.,[8] Manjuran and Arora,[13] and Kjaer[20] reported that no significant difference in latencies for Wave V between subgroups of older and younger subjects. Chu[14] and Khatoon et al.[18] showed small progressive prolongation in the peak latency with increasing age particularly peak Trune et al.[12],

Manjuran and Arora,[13] Harinder,[1] Khatoon et al.[18] and Kjaer[20] found BAEP Waves V significantly higher in males as compared to females. Chu,[14] Aoyagi et al.,[15] and Jatiya et al.[16] showed Wave III latency significantly shorter in females than males.

The increased latency which was observed in elderly individuals could be due to degenerative changes such as auditory nerve atrophy, synaptic delay, and peripheral hearing loss with age. Increasing age also causes neuronal loss and changes in the permeability of the neural membrane, which might have led to the increased latencies of the BAEP. Prolonged latency due to age may be progressive neural atrophy within peripheral and central auditory system with advanced age. The reduction of wave latencies in female than in male could be due to skull size. Hence, shorter corresponding segments of the auditory pathway due to smaller brain size in female. It may be due to the difference in hormones. Ovarian steroids, estrogen, and progesterone affected the synaptic transmission at the level of the brainstem. The probable explanation is the modulation in the secretion of gamma-aminobutyric acid (GABA) in a counter-regulatory fashion. Estrogen may enhance the inhibitory effects of GABA by stimulating its secretion, thereby delaying its conduction. Conversely, progesterone may decrease the sensitivity of the neurons and blunt the estrogen potentiated GABA release. The high level of estrogen seen during pregnancy is believed to decrease the auditory conduction process.

However, study done in single college of Bhavnagar city of Gujarat limits us to generalize the results. There is definitely a need for well-planned, large-scale studies to get normal range of latencies and amplitude of waveforms of BAEP in healthy normal person.

CONCLUSION

BAEP studies may be influenced differently in normal hearing and hearing loss subjects by the age factor. It is also found that these BAER parameters in females are with shorter values compared to men. Significant changes in the BAEPs in our study support the possible role of age and gender as contributively factors for normal variations.

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