STUDY OF BRAINSTEM AUDITORY EVOKED POTENTIALS (BAEP) IN NORMAL HEALTHY PERSONS IN VARIOUS AGE GROUPS.
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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 BAEPs deserve keen appraisal for correct clinical application and inference. Objective: To get normal range of latencies and amplitude of waveforms of BAEP in healthy normal persons in various age groups. Methods: BAEPs from either ear of normal hearing 150 men and 145 women in 1 year to 73 year age range were studied. Absolute peak latencies of waves I, II, III, IV and V were examined in reference to influence of age and gender. Result: In male, wave I value was significantly higher in ≥ 45 years age group than 1-14, 15-24 and 25-34 years age groups. In female, wave I is significantly higher in 35-44 and ≥ 45 years age groups. i.e at extreme of age group ≥45 yrs, it was 1.77±0.18. The latency of wave II was significantly higher in 35-44 and ≥ 45 years age groups in male i.e 2.74±0.17, 2.78±0.17 respectively. In female, wave II significantly higher in 35-44 and ≥ 45 years age groups i.e 2.70±0.18, 2.80±0.15 respectively. There were significant higher latencies of wave III in 35-44 and ≥ 45 years age groups in male i.e 3.81±0.15, 3.86±0.12 respectively. There was no significant difference found for wave IV in different age groups in male. The latency of wave IV was significantly higher in ≥ 45 years age group compared to 25-34 years age group in female i.e at extreme of age group ≥45 yrs, it was 4.84±0.20. There was no significant difference found for wave V in different age groups in male and female respectively. 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, BAEP, Auditory pathway, hearing, Healthy Person

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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. 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, Paediatric.2, 3, 4 BAEPs consist of a series of five positive waves occurring within 10ms, following the acoustic stimulus and are labeled I to V in Roman. The waves depict neuro-electrical 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, in order to elucidate the significance of BAEP in diagnosis, the first step in interpretation requires the identification of the waveforms of BAEP. Thus, present study is undertaken to get normal range of latencies and amplitude of waveforms of BAEP in healthy normal persons in various age groups.

**Material and methods**

Present study was carried out at electrophysiology laboratory in Physiology Department of Government Medical College, Bhavnagar, Gujarat between January 2012 to January 2014. The study protocol was examined and approved by 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 20dB (decibels) at routine frequencies were included. In all, 295 subjects 150 men and 145 women participants were finally included in study. They were in age range of 1 years to 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 lobe (A1/A2); at the vertex (Cz), as the reference electrode in 10/20 electrode placement system, and on the fore head (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/second were presented mono-aurally through earphone. Intensity of stimulus was 90dB. 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, II, III, IV and V were selectively measured. Waves VI and VII were not clearly defined with the apparatus system. Thus collected data was analyzed using Microsoft excel software. (TrialVersion). Student’s t test and one way ANNOVA test were applied.

**Results**

Total 295 participants (150 men and 145 women) were finally included in study. They were in age range of 1 year to 73 years. They were divided in 1-14, 15-24, 25-34, 35-44 and ≥ 45 years age groups and labeled as group 1,2,3,4 and 5 respectively. Wave I which is generated in the eight nerve had mean latency in age group 1-14yrs,15-24yrs,25-34 yrs,35-44 yrs and ≥45 yrs were 1.59 ± 0.13, 1.65 ± 0.16, 1.73 ± 0.16, 1.74 ± 0.17 and 1.83 ± 0.13 respectively in male and female. Wave I value is significantly higher in ≥ 45 years
age group than 1-14, 15-24 and 25-34 years age groups. There is no significant difference between 15-24, 25-34 and 35-44 years age groups. i.e at extreme of age group ≥45 yrs, it was 1.83±0.13. In female, wave I is significantly higher in 35-44 and ≥ 45 years age groups. i.e. at extreme of age group ≥45 yrs, it was 1.77±0.18. (Figure:1)

Wave II which is generated in cochlear nucleus had mean latency in age group 1-14 yrs, 25-34 yrs, 35-44 yrs and ≥45 yrs were 2.54 ± 0.21, 2.64 ± 0.14, 2.64 ± 0.19, 2.74 ± 0.17 and 2.78 ± 0.17 respectively in male while in female it were 2.62 ± 0.10, 2.56 ± 0.27, 2.56 ± 0.23, 2.70 ± 0.18, 2.80± 0.15 respectively. The latency of wave II was significantly higher in 35-44 and ≥ 45 years age groups in male i.e 2.74±0.17, 2.78±0.17 respectively. In female, wave II significantly higher in 35-44 and ≥ 45 years age groups i.e 2.70±0.18, 2.80±0.15 respectively. (Figure:2)

Wave III which had mean latency in age group 1-14 yrs, 15-24 yrs, 25-34 yrs, 35-44 yrs and ≥45 yrs were 3.76 ± 0.14, 3.70 ± 0.17, 3.73 ± 0.17, 3.81 ± 0.15 and 3.86 ± 0.12 respectively in male while in female it were 3.67 ± 0.17, 3.57 ± 0.16, 3.59 ± 0.23, 3.77 ± 0.23, 3.71 ± 0.31 respectively. There were significant higher latencies in 35-44 and ≥ 45 years age groups in male i.e 3.81±0.15, 3.86±0.12 respectively. There were significant higher latencies in 35-44 years age group in female. i.e 3.77±0.23. (Figure:3)

The wave IV which originates in the lateral lemniscus had mean latency in age group 1-14 yrs, 15-24 yrs, 25-34 yrs, 35-44 yrs and ≥45 yrs were 4.81±0.17, 4.82 ± 0.13, 4.82 ± 0.13, 4.90 ± 0.12 and 4.93 ± 0.24 respectively in male while in female it were 4.69 ± 0.21, 4.77 ± 0.20, 4.66 ± 0.29, 4.75 ± 0.26, 4.84 ± 0.20 respectively. There was no significant difference found for wave IV in different age groups in male. The latency was significantly higher in ≥ 45 years age group compared to 25-34 years age group in female i.e at extreme of age group ≥45 yrs, it was 4.84±0.20 (Figure:4)

Wave V which originates in inferior colliculi had mean latency in age group 1-14 yrs, 15-24 yrs, 25-34 yrs, 35-44 yrs and ≥45 yrs were 5.63 ± 0.26, 5.68 ± 0.20, 5.70 ± 0.23, 5.63 ± 0.23 and 5.75 ± 0.24 respectively in male while in female it were 5.48 ± 0.21, 5.55 ± 0.26, 5.50 ± 0.48, 5.55 ± 0.16 and 5.65 ± 0.44 respectively. There was no significant difference found for wave V in different age groups in male and female respectively (Figure:5)

Discussion

In our study wave I value is significantly higher in ≥ 45 years age group than 1-14, 15-24 and 25-34 years age groups in males. There was no significant difference between 15-24, 25-34 and 35-44 years age groups. i.e at extreme of age group ≥45 yrs, it was 1.83±0.13. In female, wave I is significantly higher in 35-44 and ≥ 45 years age groups. i.e at extreme of age group ≥45 yrs, it was 1.77±0.18. Rowe et al7, Stephen W H et al9, Rosehhall U et al7, Costa P et al9, Fallah TM et al9 and Oku and Hasegewa et al10 found latencies of wave I were progressively delay in the older participants due to peripheral processes.

In present study the latency of wave II was significantly higher in 35-44 and ≥ 45 years age groups in male i.e 2.74±0.17, 2.78±0.17 respectively. In female, wave II significantly higher in 35-44 and ≥ 45 years age groups i.e 2.70±0.18, 2.80±0.15 respectively. Julie V. Patterson et al11 studied age and Sex Differences in the Human. They found age effects for waves II. Harinder JS et al11 and Maria Khatoon et al12 found no significant difference for wave II in older adult compared to young adult.

In present study there were significant higher latencies of wave III in 35-44 and ≥ 45 years age groups in male i.e 3.81±0.15, 3.86±0.12 respectively. There were significant higher latencies of wave III in 35-44 years age group in female. i.e 3.77±0.23. Harinder JS et al11, Fallah TM9, Maria Khatoon et al12 showed that the older adults had prolonged wave III latencies. Rosehhall U et al7, Oku and Hasegewa et al10,
Trune DR et al. H S Johannsen et al. and Martini et al. reported that older adults had increased latency for wave III. In our study there was no significant difference found for wave IV in different age groups in male. The latency of wave IV was significantly higher in ≥ 45 years age group compared to 25-34 years age group in female i.e at extreme of age group >45 yrs, it was 4.84±0.20. Harinder J S et al. 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. H S Johannsen et al. observed that significant long latency in older subjects for wave IV.

In present study there was no significant difference found for wave V in different age groups in male and female respectively. Costa P et al. Beagley and Sheldrake et al. Mogens Kjaer et al. T J Manjuran et al. Lille F et al. reported that no significant difference in latencies for wave V between subgroups of older and younger subjects. Maria Khatoon et al. Jarger & Hall et al. and Nai-shin Chu et al. showed small progressive prolongation in the peak latency with increasing age particularly peak V.

The increased latency and the interpeak latency which were observed in elderly individuals could be due to degenerative changes like 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. Age related neuronal and structural changes within the human brainstem predict brainstem auditory evoked response differences. Findings regarding cell loss are contradictory but degenerative changes such as cell size and cell shape irregularities and accumulation of lipofusion pigments in the ventral cochlear nucleus, superior olivary nucleus, inferior colliculus, medial geniculate body and inferior olive. Degenerative changes in the myeline sheaths and axis cylinders of the structures.

Prolonged latency due to age may be progressive neural atrophy within peripheral and central auditory system with advanced age. 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 persons in various age groups.

**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.

**References**


Figure:1 Wave-I latency value comparison between various age groups
Figure: 2 Wave-II latency value comparison between various age groups

Figure: 3 Wave-III latency value comparison between various age groups

Figure: 4 Wave-IV latency value comparison between various age groups
Figure 5: Wave IV and Wave V latency values comparison between various age groups.