STUDY OF BRAINSTEM AUDITORY EVOKED POTENTIALS (BAEP) IN NORMAL HEALTHY PERSONS IN VARIOUS AGE GROUPS.

Khushbu Patel[1], Chinmay Shah[2], Hemant Mehta[2], Hemant Patel[3], Grishma Dixit[4], Nilesh Thakor[5]

1Department of Physiology, Government Medical College, Surat, Gujarat, India,
2Department of Physiology, Government Medical College, Bhavnagar, Gujarat, India, 3Department of Pediatrics, Mohanlal Dayal Hospital, Killa Pardi, Valsad, Gujarat, India, 4Department of Community Medicine, B.J. Medical College, Ahmedabad, Gujarat, India, 5Department of Community Medicine, GMERS Medical College, Gandhi Nagar, Gujarat, India

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

Corresponding Author Dr. Chinmay Shah, Associate Professor, Department of Physiology, Government Medical College, Bhavnagar, Gujarat, Email Address: researchforbetterhealth@gmail.com

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 lobule (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,15-24 yrs,25-34 yrs,35-44 yrs and $\geq$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 while in female it were 1.55 ± 0.13, 1.61 ± 0.14, 1.62 ± 0.19, 1.66 ± 0.19, 1.77 ± 0.18 respectively. In male, 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 1-14yrs,15-24 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 1-14yrs,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 ± 0.15and 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 1-14yrs,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 1-14yrs,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 al[5] , Stephen W H et al[6], Rosehhall U et al[7] ,Costa P et al[8], Fallah TM et al[9] and Oku and Hasegewa et al[10] 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 al[11] studied age and Sex Differences in the Human. They found age effects for waves II. Harinder JS et al[1] and Maria Khatoon et al[12] 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 al[1], Fallah TM[9], Maria Khatoon et al[12]showed that the older adults had prolonged wave III latencies. Rosehhall U et al[7], Oku and Hasegewa et al[10],

Trune DR et al[13], H S Johannsen et al[14] and Martini et al[15] 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[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. H S Johannsen et al[14] 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 [8], Beagley and Sheldrake et al[16], Mogens Kjaer et al [17], T J Manjuran et al[18], Lille F et al[19] reported that no significant difference in latencies for wave V between subgroups of older and younger subjects. Maria Khatoon et al[12], Jarger & Hall et al[20] and Nai-shin Chu et al[21] 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

1. Harinder J S, Ram Sarup S, Sharanjit K. The study of age and sex related changes in the brainstem auditory evoked potential. Journal of Clinical and Diagnostic Research 2010, 4:3495-3499.
2. Hulya Bilgen et al. Auditory Brain Stem Response Screening For Hearing Loss In High Risk Neonates. Turk J Med Sci, 2000; (30):479-482
3. Mjoen S, Langslet A, Tangsrud SE, Sundby A. Auditory Brainstem Responses (ABR) In High-Risk Neonates. Acta Paediatr Scand. 1982; 71(5):711-715.
4. S.K. Lau,William I. Wei. Brainstem evoked response audiometry and its application. J. Hong Kong Med Assoc, 1991 June ; 43(2):108-112
5. Rowe M J. Normal variability of the brainstem auditory evoked response in young and old subjects. Electroencephalography and clinical Neurophysiology, 1978;441:459-470.
6. Stephen W Harkins. Effect of age & interstimulus interval on the brainstem auditory evoked potential. International Journal of neuroscience 1980;15(1-2):107-118

7. Rosenhall U, Bjorkman G, Pedersen K, Kall A. Brainstem auditory evoked potentials in different age groups, Electroencephalogr Clin Neurophysiol 1985;62(6): 426-430
8. Costa P, Benna P, Bianco C, Ferrero P, Bergamasco B. Aging effects on brainstem auditory evoked potentials. Electroencephalogr Clin Neurophysiol 1990; 30(8) : 495-500
9. Fallah Tafti Mohammad, Karimi Gharib, H. Teimuri. Study of Age effect on brainstem auditory evoked potential waveforms. J. Med. Sci, 2007 November;7(8):1362-1365.
10. Oku T, Hasegewa M. The influence of aging on auditory brainstem response and electrocochleography in the elderly. Journal of otorhinolaryngology and relared specialities 1997 ;59:141-146
11. Julie V. Patterson, Henry J. Michalewski, Larry W. Thompson, Thomas E. Bowman, Debra K. Litzelman, Age and Sex Differences in the Human Auditory Brainstem. Response Journal of Gerontology, 1981 July;36(4) 455-462.
12. Maria Khatoon, Sunita Nighute , Abhijit Awari, Mohd Ishaque, The Influence Of Aging On Auditory Evoked Potential In Advanced Age Group, International Journal Of Biomedical Research.2012; 3(11):422-426
13. Dennis R Trune, Mitchell C, Phillips D S. The relative importance of head size, gender and age on the auditory brainstem response. Hear Res. 1988 Feb-March ;32 (2-3): 165-174
14. H.S.Johannsen , T. Lehn. The dependence of early acoustically evoked potentials on age. European archives of otorhinolaryngology 1984;240(2):153-158
15. Martini A, COmacchio F & Magnavita M. Auditory evoked responses (ABR, MLR, SVR) and brain mapping in elderly. Acta otolaryngologica 1990;476: 97-103
16. Beagley H A, Sheldrake M B. Differences in brainstem response latency with age and sex. British journal of Audiology 1978;12:69-77
17. Mogens Kjaer. Differences of latencies and amplitudes of brainstem evoked potentials in subgroups of a normal material. Acta Neurologica Scandinavica 1979 ;59(2):72-79
18. T.J. Manjuran , M. M. L Arora. Brainstem evoked response audiometry; the variantions in latencies and amplitude of normal subjects of different sex and age group. Indain journal of otolaryngology and Head & Neck surgery 34(3):39-41
19. Lille F, Hassine L, Margules S. Evoked potentials and age : different aging by sex? Neurophysiol Clin 1991;21(5-6):459-72
20. Jerger J, Hall J. Effects of age and sex on auditory brainstem response. Arch Otolaryngol. 1980 Jul;106(7):387-91
21. Chu NS. Age-related latency changes in the brain-stem auditory evoked potentials. Electroencephalogr Clin Neurophysiol. 1985 Nov;62(6):431-436.

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

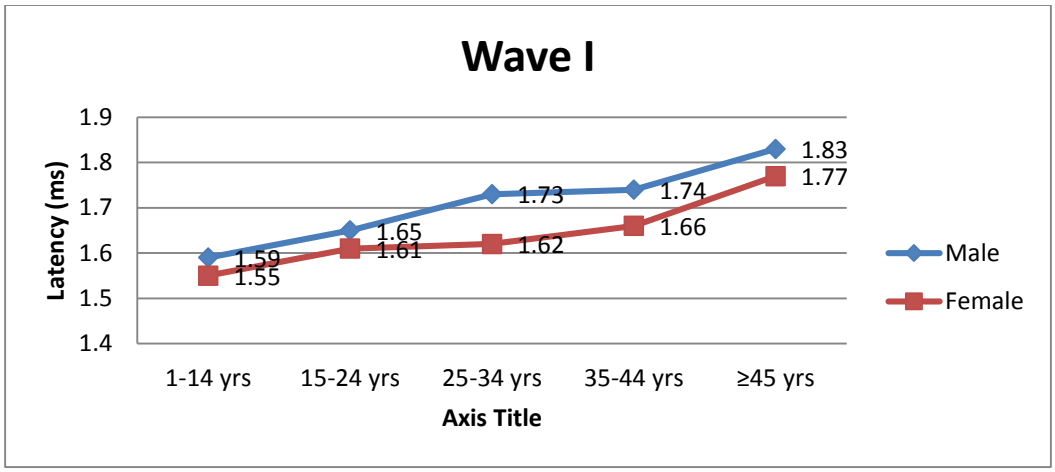

Figure:2 Wave-II latency value comparison between various age groups

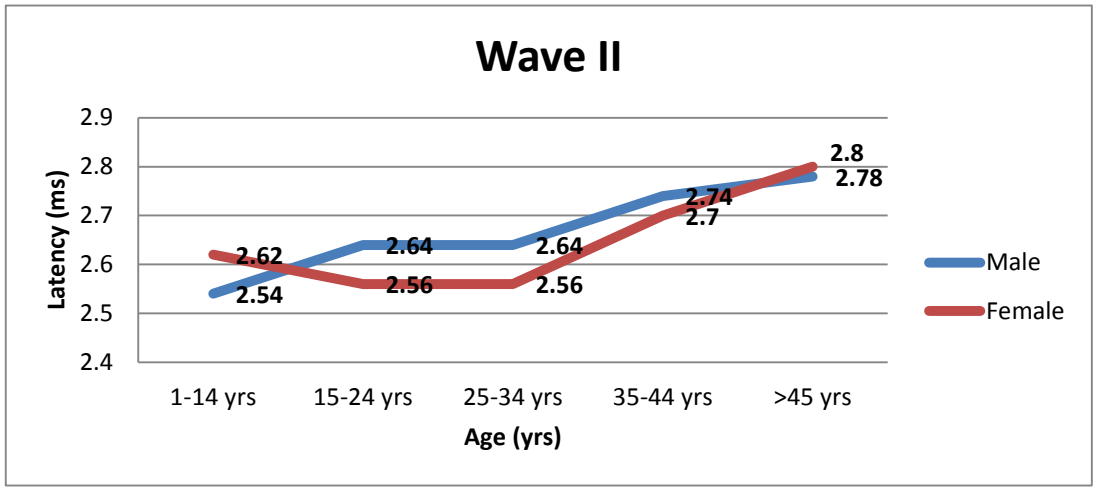

Figure:3 Wave-III latency value comparison between various age groups

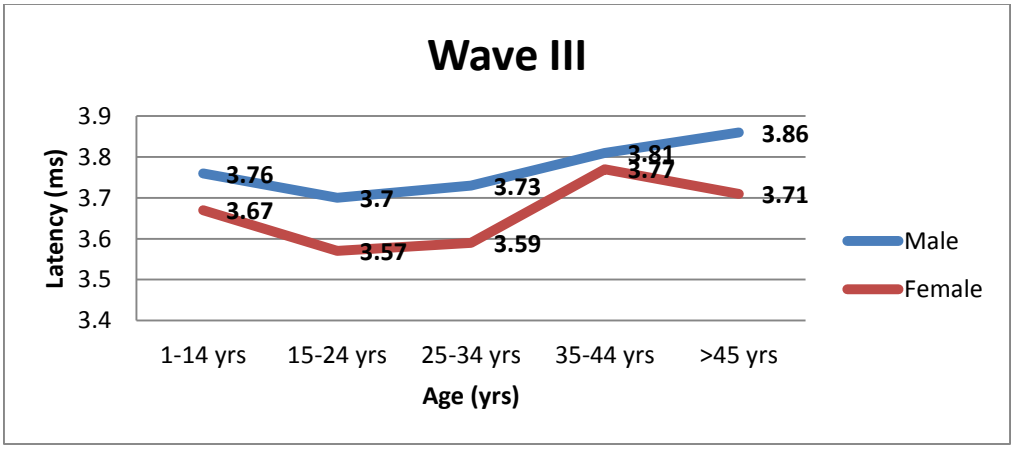

Figure:4 Wave- IV latency value comparison between various age groups

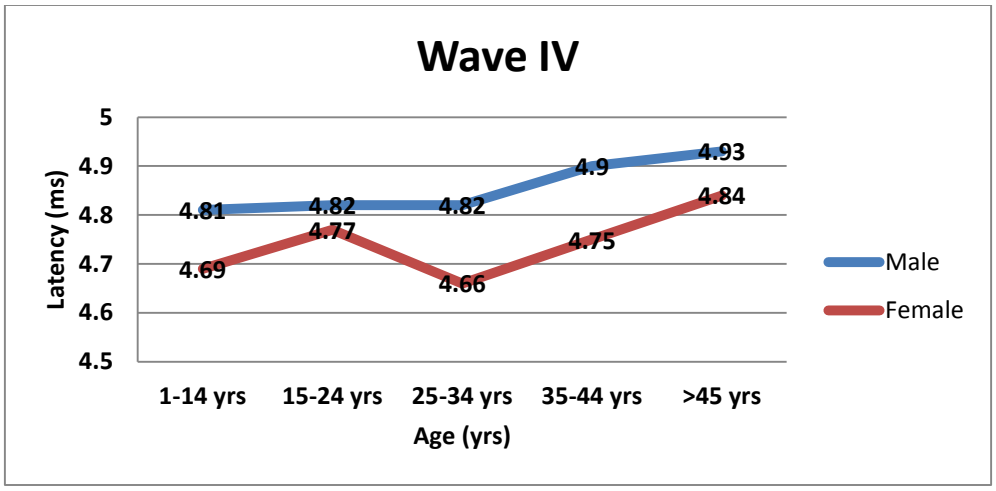

Figure:5 Wave- V latency value comparison between various age groups