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RESEARCH ARTICLE

Study of interpeak latencies of waveforms 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 Objectives:** Aims and objectives of the study were to get normal range of interpeak latencies (IPLs) 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 IPLs of waves I-III, III-V, and I-V were examined in reference to influence of age and gender. **Result:** The IPLs of waves I-III value are significantly higher in males in ≥45 years age groups than in females. The IPLs of waves I-III value are highest 1-14 years age groups and 35-44 years age group in males and females, respectively. The IPLs of waves III-V value are highest 25-34 years age groups and ≥45 years age groups in males and females, respectively. The IPLs of waves III-V value are significantly higher in females in ≥45 years age groups than in males. The IPLs of waves I-V value are highest 1-14 years age groups and ≥45 years age groups in males and females, respectively. **Conclusion:** Significant changes in IPLs of waveforms of BAEPs in our study support the possible role of age and gender as contributive factors for normal variations.

KEY WORDS: Inter Peak Latencies; 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 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, 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 interpeak latencies (IPLs) 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 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 (decibels) at routine frequencies were included in the study. 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 IPLs, between wave I-III; III-V and I-V were measured from peak to peak of two defined waveforms and hearing threshold. Thus, collected data were analyzed using Microsoft excel software. (Trial version). Student's *t*-test and one-way ANNOVA test were applied.

RESULTS

The IPLs of waves I-III value are significantly higher in males in ≥45 years age groups than in females. The IPLs of waves I-III value are higher in males in all group except in 35-44 years age groups than in females. The IPLs of waves I-III value are highest 1-14 years age groups and 35-44 years age group in males and females, respectively (Table 1). The IPLs of waves III-V value are highest 25-34 years age groups and ≥45 years age groups in males and females, respectively. The IPLs of waves III-V value are higher in males in all group except in ≥45 years age groups than in females. The IPLs of waves III-V value are significantly higher in females in ≥45 years age groups than in males (Table 2). The IPLs of waves I-V value are highest 1-14 years age groups and ≥45 years age groups in males and females, respectively. The IPLs of waves I-V value are higher in males in all group except in years 35-44 years age groups and ≥45 years age groups than in females (Table 3).

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, and neonatology.

In our study, the IPLs of waves I-III value are significantly higher in males in ≥45 years age groups than in females. The IPLs of waves I-III value are higher in males in all group except in 35-44 years age groups than in females. The IPLs of waves I-III value are highest 1-14 years age groups and 35-44 years age group in males and females. In our study,

Table 1: Interpeak (wave I-III) latency value (mean±SD values) comparison between various age groups in both gender

Age groups (years)	Male	Female	*P* value
1-14	2.17±0.18	2.12±0.18	0.2662
15-24	1.97±0.23	1.96±0.21	0.7887
25-34	2.00±0.25	1.95±0.27	0.4972
35-44	2.07±0.21	2.13±0.34	0.3628
>45	2.03±0.17	1.93±0.16	0.0243

SD: Standard deviation

Table 2: Interpeak (wave III-V) latency value (mean±SD values) comparison between various age groups in both gender

Age groups (years)	Male	Female	*P* value
1-14	1.87±0.34	1.82±0.23	0.4620
15-24	1.98±0.20	1.98±0.31	0.9561
25-34	1.98±0.21	1.90±0.52	0.4611
35-44	1.82±0.23	1.78±0.33	0.5632
>45	1.89±0.26	2.08±0.27	0.0324

SD: Standard deviation

Table 3: Interpeak (wave I-V) latency value (mean±SD values) comparison between various age groups in both gender

Age groups (years)	Male	Female	*P* value
1-14	4.04±0.28	3.93±0.27	0.1054
15-24	3.95±0.25	3.94±0.28	0.8044
25-34	3.98±0.24	3.85±0.46	0.1789
35-44	3.89±0.28	3.89±0.30	0.9146
>45	3.92±0.28	3.94±0.35	0.8179

SD: Standard deviation

the IPLs of waves I-III value did not increase with advancing age. In Chu,[5] Oku and Hasegewa[6] and Costa et al.[7] noted that the IPL values did not increase with increasing age. In Khatoon et al.,[8] Mohammad,[9] Harinder et al.[1] and Rowe[10] found prolongation of I-III IPLs as the age is increasing from younger to older. In Chu,[5] Harinder et al.,[1] Thivierge and Côté,[11] Aoyagi et al.[12] and Solanki et al.[13] found that wave I-III IPL was shorter for female than the male.

In this study, the IPLs of waves III-V value are highest 25-34 years age groups and ≥45 years age groups in males and females, respectively. The IPLs of waves III-V value are higher in males in all group except in ≥45 years age groups than in females. The IPLs of waves III-V value is significantly higher in females in ≥45 years age groups than in males. Costa et al.[7] and Harinder et al.[1] found no significant change in III-V IPL between younger and older subjects. Chu,[5] Khatoon et al.,[8] Mohammad et al.,[9] and Uziel et al.[14] found prolongation of III-V IPL as the age is increasing from younger to older. Chu[5], Harinder et al.,[1] Solanki et al.,[13] and Trune et al.[15] found that the genders were significantly correlated with the latencies of waves III-V, Male had longer latencies than female. Aoyagi et al.[12] showed no gender difference found for III-V IPL in male and female.

In our study, the IPLs of waves I-V value are highest 1-14 years age groups and ≥45 years age groups in males and females, respectively. The IPLs of waves I-V value are higher in males in all group except in years 35-44 years age groups and ≥45 years age groups than in females. Costa et al.,[7] Harkins et al.,[16] and Rosenhall et al.[17] noted the I-V IPL remains the same in all age groups. Harinder et al.[10] showed I-V IPL increased in older males as compared to the young males. Solanki et al.[13] found no significant gender difference for I-V IPL between male and female in teenage group. Chu,[5] Khatoon et al.,[8] Harinder et al.,[1] Aoyagi et al.,[12] and Trune et al.[15] found significantly increased values of the interpeak latencies of I-V waves in males compared to females.

The increased IPL 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. The reduction of IPLs 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. The hormone levels were not assessed in our study, therefore, the role of hormones being responsible for difference in the BAEP latencies cannot be conclusively stated.

However, the study was 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

IPLs value of waveforms of brain-stem auditory evoked response in females is shorter as compared to men. Significant changes in IPLs of waveforms of BAEPs in our study support

the possible role of age and gender as contributive factors for normal variations.

REFERENCES

1. Harinder JS, Sarup SR, Sharanjit K. The study of age and sex related changes in the brainstem auditory evoked potential. J Clin Diagn Res. 2010;4:3495-9.
2. Bilgen H, Akman I, Özek E, Külekç S, Örs R, Carman KB, et al. Auditory brain stem response screening for hearing loss in high risk neonates. Turk J Med Sci. 2000;30:479-82.
3. Mjøen S, Langslet A, Tangsrud SE, Sundby A. Auditory brainstem responses (ABR) in high-risk neonates. Acta Paediatr Scand. 1982;71(5):711-5.
4. Lau SK, Wei WI. Brainstem evoked response audiometry and its application. J Hong Kong Med Assoc. 1991;43(2):108-12.
5. Chu NS. Age-related latency changes in the brain-stem auditory evoked potentials. Electroencephalogr Clin Neurophysiol. 1985;62(6):431-6.
6. Oku T, Hasegewa M. The influence of aging on auditory brainstem response and electrocochleography in the elderly. ORL J Otorhinolaryngol Relat Spec. 1997;59(3):141-6.
7. Costa P, Benna P, Bianco C, Ferrero P, Bergamasco B. Aging effects on brainstem auditory evoked potentials. Electromyogr Clin Neurophysiol. 1990;30(8):495-500.
8. Khatoon M, Nighute S, Awari A, Ishaque M. The influence of aging on auditory evoked potential in advanced age group. Int J Biomed Res. 2012;3(11):422-6.
9. Mohammad FT, Gharib K, Teimuri H. Study of age effect on brainstem auditory evoked potential waveforms. J Med Sci. 2007;7(8):1362-5.
10. Rowe MJ 3rd. Normal variability of the brain-stem auditory evoked response in young and old adult subjects. Electroencephalogr Clin Neurophysiol. 1978;44(4):459-70.
11. Thivierge J, Côté R. Brain-stem auditory evoked response (BAER): Normative study in children and adults. Electroencephalogr Clin Neurophysiol. 1987;68(6):479-84.
12. Aoyagi M, Kim Y, Yokoyama J, Kiren T, Suzuki Y, Koike Y. Head size as a basis of gender difference in the latency of the brainstem auditory-evoked response. Audiology. 1990;29(2):107-12.
13. Solanki JD, Joshi N, Mehta HB, Shah CJ. A study of gender, head circumference and BMI as a variable affecting BAEP results of late teenages. Indain J Otol. 2012;18(1):3-4.
14. Uziel A, Baldy-Moulinier M, Marot M, Abboudi C, Passouant P. Auditory brainstem potentials in old adult subjects (author's transl). Rev Electroencephalogr Neurophysiol Clin. 1980;10(2):153-60.
15. Trune DR, Mitchell C, Phillips DS. The relative importance of head size, gender and age on the auditory brainstem response. Hear Res. 1988;32(2-3):165-74.
16. Harkins SW. Effects of age and interstimulus interval on the brainstem auditory evoked potential. Int J Neurosci. 1981;15(1-2):107-18.
17. Rosenhall U, Björkman G, Pedersen K, Kall A. Brain-stem auditory evoked potentials in different age groups. Electroencephalogr Clin Neurophysiol. 1985;62(6):426-30.

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