Journal of Medical Sciences

ISSN 1682-4474

science alert

ANSInet
an open access publisher
http://ansinet.com

Research Paper

JMS (ISSN 1682-4474) is an International, peer-reviewed scientific journal that publishes original article in experimental & clinical medicine and related disciplines such as molecular biology, biochemistry, genetics, biophysics, bio-and medical technology. JMS is issued eight times per year on paper and in electronic format.

For further information about this article or if you need reprints, please contact:

Fallah Tafti Mohammad
IBTO bldg, Hemmat Exp. Way,
Next to the Milad Tower,
Tehran, Iran

J. Med. Sci., 7 (8): 1362-1365
15th November, 2007

Study of Age Effect on Brainstem Auditory Evoked Potential Waveforms

Fallah Tafti Mohammad, Karimi Gharib and H. Teimuri

Age is one of the important factors in the clinical interpretation of Brainstem Auditory Evoked Potential (BAEP) waveform components and it can change the value of peak latencies and interpeak latencies among different age groups. The present study aims to measure all BAEP waveform peak latencies and interpeak latencies and to evaluate changes in standard deviation in 77 normal adult male subjects in age groups of 10-20, 20-30, 30-40, 40-50 and 50-60 years. The results obtained in this study show that as the age rises from 10 to 60 years, so do the values in peak latencies and interpeak latencies of all BAEP waveforms recorded from ipsilateral and contralateral ears. For example, the changes in value of wave I that belong to age group of 10-20 years come out to be 1.53±0.005 ($p<0.001$) while changes in the same wave for the age group of 50-60 years was 1.83±0.035 ($p<0.001$). I-III interpeak latency values from younger to older age groups vary from 1.96±0.014 ($p<0.001$) to 2.08±0.148 ($p<0.005$), respectively. The results in this study show that the variation related to waves I, III and V peak latencies of younger age groups in both ears is smaller than older and that changes attributed to ipsilateral ears are slightly smaller than values of contralateral ears in all age groups. While I-III, III-V and I-V interpeak latencies in all age groups had an increased value.

Key words: BAEP, age groups, peak latencies, interpeak latencies

ANSInet
Asian Network for Scientific Information

Iranian Blood Transfusion Organisation Research Center,
Medical Science University of Iran, Iran

INTRODUCTION

The Brainstem Auditory Evoked Potential (BAEP) is now considered as the most used precocious potential in clinical practices and provides valuable information about the peripheral auditory pathway. This potential helps characterize the level of brain damage, space occupying lesions, subjects with neurological disorders (Shannon *et al*., 1979), postmenopausal women on hormone replacement therapy (Farah *et al*., 2003) and the like.

At the time of BAEP waveforms recording, several factors may affect the peak latencies (time interval between the stimulus and a specific peak on waveform), interpeak latencies (difference between two peaks) and their amplitudes. These factors are classified as recording variables (electrodes, reference, filters), stimulus variables (stimulus intensity, stimulus rate, stimulus mode and stimulus phase) and subject variables (age, sex, temperature).

The BAEP recorded from a normal human subject as shown in Fig. 1 is composed of several waves or peaks (Egger Mont *et al*., 1990) with different amplitudes and frequencies which appear within 10 msec shortly after the stimulus known as Jewett waves, labeled using Roman numerals I-VII was elicited.

As it is mentioned in earlier studies, progression in age will directly affect the peak latency and interpeak latency value of all BAEP waveform components (Salamy and McKean, 1976; Huszar, 2002). For this reason, the present study aims to describe the amount of changes achieved in peak latencies and interpeak latencies of BAEP waveform components recorded from ipsilateral and contralateral ears of 77 normal adult subjects aged from 10 to 60 years.

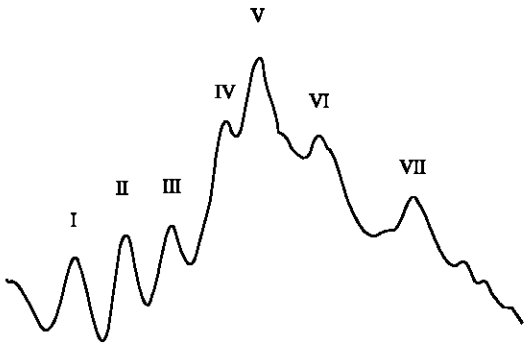

Fig. 1: The anatomical structures of these responses (Clroux *et al*., 1983) are: wave I-corresponding to action potential of auditory nerve, wave II-arise by the ipsilateral cochlear nucleus and intracranial portion of the 8th nerve. Wave III-is generated from the superior olivery complex, wave IV-corresponds to the activity of lateral lemniscuses, wave V-corresponds to the activity in the inferior colliculus, wave VI-probably is generating in the medial geniculate, wave VII-corresponds to generator activity at the auditory radiations

MATERIALS AND METHODS

The BAEP recording is obtained from 3 electrodes placed on vertex (Cz = active), the ipsilateral mastoid (M2 = reference) and forehead (Fpz = ground). The electrode was placed according to the 10-20 system. The amplification was 200000 to 500000 and the band pass ranged from 30 to 3000 Hz. The average response for the first 10 msec extends from 2000 to 4000 clicks and is displayed on oscilloscope screen. During the recording, the ear can elicit a variety of stimuli such as click, pips and tone bursts but the preferred stimulus for clinical neurology investigation of the cochlear nerve and brainstem auditory pathways is a click. So the repeated click at a frequency of 20 sec^{-1}. was transmitted to each ear with an intensity of 90 db above hearing threshold levels. The non-stimulated ear was masked by white noise.

The recorded BAEPs are non-invasive measures of the subcortical auditory pathway's functional integrity, produced in response to a brief acoustic stimulation by using scalp electrodes. Because of poor signal to noise ratio, it is necessary to average several hundreds of signal responses to get a recognizable (Vannier *et al*., 2002) BAEP waveform.

RESULTS

In this study, 77 normal adult male subjects aged from 10 to 60 years were sampled. In the data analysis, the recorded results are grouped according to patients' age ranges of 10-20(14), 20-30(14), 30-40(15), 40-50(19) and 50-60(15) years.

These data contain valuable information about the variations that occur in I, III and V peak latency and interpeak latency values of subjects in various age groups (Table 1, 2). The data collected from both ears showed that any increases in age will cause an increase in peak latency and interpeak latency values of all waves. The value attributed to peak latencies and interpeak latencies recorded from ipsilateral were ranges lower than data collected from contralateral ears. For example, increasing trend in age from younger (10-20) to older (50-60) caused the values of waves I, III, V peak latencies and interpeak

Table 1: Mean absolute peak latency values in ipsilateral and contralateral ears

Peak latencies	Age groups	No. of males and females	Peak latencies (msec) Ipsilateral ear	Contralateral ear
I	10-20	N(m) = 7, N(w) = 7	0.005±1.53 (p<0.001)	0.270±1.72 (p<0.0001)
	20-30	N(m) = 8, N(w) = 6	0.048±1.61 (p<0.001)	0.134±1.74 (p<0.001)
	30-40	N(m) = 9, N(w) = 6	0.011±1.65 (p<0.0015)	0.232±1.83 (p<0.01)
	40-50	N(m) = 7, N(w) = 12	0.015±1.67 (p<0.0001)	0.098±1.82 (p<0.001)
	50-60	N(m) = 7 N(w) = 8	0.035±1.85 (p<0.001)	151.0±1.89 (p<0.001)
III	10-20	N(m) = 7, N(w) = 7	0.153±3.49 (p<0.0016)	0.128±3.51 (p<0.0016)
	20-30	N(m) = 8, N(w) = 6	0.068±3.61 (p<0.004)	0.019±3.64 (p<0.004)
	30-40	N(m) = 9, N(w) = 6	0.013±3.67 (p<0.003)	0.043±3.70 (p<0.001)
	40-50	N(m) = 7, N(w) = 12	0.122±3.82 (p<0.002)	0.073±3.87 (p<0.001)
	50-60	N(m) = 7, N(w) = 8	0.038±3.93 (p<0.001)	0.072±3.93 (p<0.005)
V	10-20	N(m) = 7, N(w) = 7	0.081±5.46 (p<0.0016)	0,094±5.66 (p<0.004)
	20-30	N(m) = 8, N(w) = 6	0.021±5.59 (p<0.001)	0.018±5.69 (p<0.00)
	30-40	N(m) = 9, N(w) = 6	0.028±5.70 (p<0.004)	0.034±5.82 (p<0.006)
	40-50	N(m) = 7, N(w) = 12	0.032±5.75 (p<0.001)	0.055±5.85 (p<0.001)
	50-60	N(m) = 7, N(w) = 8	0.073±5.80 (p<0.001)	0.083±5.83 (p<0.004)

Table 2: Mean interpeak latency values in ipsilateral and contralateral ears

Peak latencies	Age groups	No. of males and females	Peak latencies (msec) Ipsilateral ear	Contralateral ear
I-III	10-20	N(m) = 7, N(w) = 7	0.148±1.96 (p<0.001)	0.142±1.79 (p<0.004)
	20-30	N(m) = 8, N(w) = 6	0.020±2.00 (p<0.002)	0.115±1.90 (p<0.001)
	30-40	N(m) = 9, N(w) = 6	0.107±2.02 (p<0.004)	0.189±1.87 (p<0.002)
	40-50	N(m) = 7, N(w) = 12	0.003±2.15 (p<0.004)	0.025±2.05 (p<0.001)
	50-60	N(m) = 7, N(w) = 8	0.148±2.08 (p<0.004)	0.079±2.04 (p<0.01)
III-V	10-20	N(m) = 7, N(w) = 7	0.072±1.97 (p<0.00)	0.034±2.15 (p<0.002)
	20-30	N(m) = 8, N(w) = 6	0.047±1.98 (p<0.004)	0.001±2.05 (p<0.001)
	30-40	N(m) = 9, N(w) = 6	0.015±2.03 (p<0.002)	0.009±2.12 (p<0.006)
	40-50	N(m) = 7, N(w) = 12	0.090±1.93 (p<0.001)	0.018±1.98 (p<0.002)
	50-60	N(m) = 7, N(w) = 8	0.035±1.87 (p<0.004)	0.010±1.90 (p<0.002)
I-V	10-20	N(m) = 7, N(w) = 7	0.027±3.93 (p<0.00)	0.176±3.94 (p<0.001)
	20-30	N(m) = 8, N(w) = 6	0.076±3.98 (p<0.002)	0.116±3.95 (p<0.001)
	30-40	N(m) = 9, N(w) = 6	0.017±4.05 (p<0.004)	0.198±3.99 (p<0.00)
	40-50	N(m) = 7, N(w) = 12	0.017±4.08 (p<0.002)	0.043±4.03 (p<0.001)
	50-60	N(m) = 7, N(w) = 8	0.038±3.95 (p<0.001)	0.068±3.91 (p<0.001)

latencies increase accordingly. The calculated mean latency differences between the waves I, III and V recorded from ipsilateral ears of younger versus older subjects showed the values of 0.32, 0.44 and 0.34 msec. While the corresponding values recorded from contralateral ears were 0.17, 0.42 and 0.17 msec, respectively The mean interpeak latency differences (I-III, III-V and I-V) between the same age groups (younger versus older) recorded from ipsilateral ears came out to be 0.12, 0.10 and 0.02 msec, while the values from contralateral ears were 0.25, 0.25 and 0.04 msec, respectively.

The mean values taken from mean peak latency values of waves I, III, V and values of I-III, III-V, I-V interpeak latency recorded from contralateral ears are not very much prolonged compared to ipsilateral ears in all subjects and thus can be somehow negligible (Table 1, 2).

DISCUSSION

There are various studies indicating that age increase after childhood result an increase in absolute peak latencies and interpeak latencies of all BAEP waveform components (Rowe, 1978; Jerger and Hall, 1980; Fallah Tafti *et al*., 2006). Jerger and Hall in their study of changes with peak latency value of wave V recorded from ipsilateral ears of 92 male subjects aged from 20 to 79 years manifested that by age increasing trend from younger to older the peak latency values of wave V increase from 5.70 to 5.89 msec. Salamy in his study with 13 mixed adult subjects found a mean absolute peak latency value of 5.55 msec for the same wave (Salamy and McKean, 1976). In the present study, the amount of peak latency value changes for wave V of different age groups came out to be 5.46 msec within the age range 10-20 years, 5.59 msec within 20-30, 5.70 msec within 30-40, 5.75 msec within 40-50 and 5.80 msec within 50-60 years, respectively.

The data in Table 1 show that the changes in age will change peak latency values of waves I, III and V recorded from ipsilateral and contralateral ears. The amount of change in peak latency values of waves I and V recorded from both ipsilateral and contralateral ears in younger age groups were 1.53 and 5.46 msec and in older 1.85 and 5.80 msec. Whereas the corresponding values recorded from contralateral ears were 1.72, 5.66, 1.89 and 5.83 msec, respectively. The achieved data from both ears of the two age groups are not significantly different from the previously reported results (Fallah Tafti *et al*., 2006).

Interpeak latency values of I-III, III-V and I-V recorded from ipsilateral and contralateral ears of all age

groups. As it is shown, the variation in I-III interpeak latency is comparatively larger in value than III-V and I-V interpeak latencies from both ipsilateral and contralateral ears; the mean difference between the two interpeak latency values of younger and older age groups in both ears is a little larger than normal. For example, the calculated I-III interpeak latency values from ipsilateral ears of younger and older age groups were 1.96 and 2.08 msec, respectively while the corresponding values in contralateral ear were 1.79 and 2.05 msec, respectively (Table 2). Another study on I-V interpeak latency values from ipsilateral and contralateral ears in younger adult subjects showed that the value of 0.44 msec (Hecox, 1974) whereas the same value in the present research is 0.02 msec. The other study in verification of the amount of different interpeak latency values in younger and older age groups recorded just from ipsilateral ears, showed a difference value of 0.06 msec (Rowe, 1978), whereas the corresponding value in this study is 0.03. In the same study the changes in I-III interpeak latencies between two younger (mean age of 25 years) and older (mean age of 61 years) age groups were found to be 0.2 msec (Rowe, 1978), whereas the corresponding value in the present study for younger (mean age of 31.6 years) and older (mean age of 63.2 years) age groups are 0.14 msec.

The amount of changes in the BAEP waveform components can be validated by calculation of Standard Deviations (SD). The calculated standard deviation in each peak latency and interpeak latency can give an effective image about the normality or abnormality of the resulted peak and interpeak latencies values. A study on standard deviations of I-III, III-V and I-V interpeak latencies recorded from a mixed gender adult subjects aged from 5 to 33 years showed the values of 0.1, 0.02 and 0.12 msec (Salamy and McKean, 1976), whereas the corresponding values in the present study were 0.085, 0.052 and 0.035 msec, respectively.

In this study, the calculated standard deviation values shown in Table 1 and 2 as the measured mean values plus 1 SD or less than 2 SD fall within the normal limits (Stockard *et al*., 1978). Thus, the present results are compatible with the previous; they can also be useful to identify any audiological and neuropathological disorders while analyzing the brainstem waveforms.

REFERENCES

Clroux, A.P., L.W. Pratt and W. Maine, 1983. Brainstem evoked response audiometry. J. Ann. Otol. Rhinol. Laryngol., 92: 183-186.

Egger Mont, J.J. and P.H. Schmidt and Amsterdam, 1990. The Auditory Brainstem Response. In: Evoked Potentials Manual, Colon, E.J. and S.L. Visser (Eds.). Kluwer Academic Press.

Fallah, Tafti, M., A. Gharabaghian and M.M. Shooshtari, 2006. Effect of stimulus intensity rates on waves I and V of Brainstem Auditory Evoked Potentials (BAEP) in different age groups and sex. J. Pejouhandeh, 51: 179-182.

Farah, K., O.P. Tandon and N. Goal, 2003. Auditory evoked responses in postmenopausal women on hormone replacement therapy. Indian J. Pharmacol., 74: 393-399.

Hecox, K., 1974. Brainstem auditory evoked responses in human infants and adults. J. Arch. Otolaryngol., 99: 30-33.

Huszar, L., 2002. Brainstem auditory evoked potential responses. J. Clin. Utility Evoked Potentials, 30: 1-8.

Jerger, J. and J. Hall, 1980. Effect of age and sex on auditory brainstem response. J. Arch. Otolaryngol., 106: 387-391.

Rowe, M.J., 1978. Normal variability of the brainstem auditory evoked response in young and old adult subjects. J. EEG Clin. Neurophysiol., 44: 459-470.

Salamy, A. and McKean, 1976. Postnatal development of human brainstem potentials during the first year of the life. J. EEG Clin. Neurophysiol., 40: 418-426.

Shannon, E., S. Gold, L.M.Z. Himmelfarb and R. Carasso, 1979. Auditory potentials of cochlear nerve and brainstem in multiple sclerosis. J. Arch. Otolaryngol., 105: 505-508.

Stockard, J.J., J.E. Stockard and F.W. Sharbrough, 1978. Nonpathologic factors influencing brainstem auditory evoked potentials. Am. J. EEG. Technol., 18: 177-209.

Vannier, E., O. Adam and J.F. Mosch, 2002. Objective detection of brainstem auditory evoked potential with a periori information from higher presentation level. J. Artificial Int. Med., 25: 283-301.