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BRAINSTEM AUDITORY EVOKED POTENTIAL IN DIFFERENT AGE GROUPS

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ABSTRACT

Brainstem auditory evoked potential is a physiological technique for evaluation of auditory pathway. A number of electrical potentials can be recorded from the human scalp following acoustic stimulation. The potentials which occur within 10 msec of the stimulus onset termed the brain stem auditory evoked potentials (BAEPs). Latency appears to be the most stable measure and in consequence knowledge of the exact limits of normal latency of each wave is important. Since age effects on central conduction time in the acoustic pathway are still debated, the following study was conducted to investigate possible age differences in BAEP component latencies in different age groups. BAEP were elicited from seventy five normoacoustic male subjects aged from 11-60 years. The recorded results are grouped according to patients age ranges of 11-20 (15), 21-30 (15), 31-40 (15), 41-50 (15) and 51-60 (15) years. The absolute peak latency of waves I, III & V and interpeak latency of wave's I-III, III-V & I-V in various age groups are analyzed. The data collected from both ears showed that increase in age will cause an increase in peak latency and interpeak latency values of all waves. Significant changes in the BAEPs in our study support the possible role of age as contributory factors for normal variations.

Keywords: Brainstem auditory evoked potential, Absolute latency, Interpeak latency, younger, Older

1. Introduction:

Sohmer and Feinmesser (1967) were the first to publish auditory brainstem response recorded with surface electrodes in humans which showed that cochlear potentials obtained non-invasively.[1] In 1971, Jewett & Williston described description & interpretation of later waves arriving from the brainstem.[2] Evoked potentials provide a useful tool for neurophysiological research.[3] It is the record of electrical activity produced by groups of neurons within the spinal cord, brainstem, thalamus or cerebral hemispheres following stimulation of one or another specific system by means of visual, auditory, or somatosensory input. Brain stem auditory evoked potential (BAEP) recording is a physiological technique for evaluation of auditory pathway.

BAEPs are the electrical activities resulting from the activation of the eighth nerve, cochlear nucleus, tracts and nuclei of the lateral lemniscus and inferior colliculus.[4] The clinical applications of BAEP consist of identification of neurological abnormalities in the VIIIth nerve & auditory pathways of brainstem and the estimation of hearing sensitivity**.** It is a measure of neural synchrony of the time-locked, onset-sensitive, single-unit activity in the auditory nerve and the brainstem.[5] Stimuli with a very rapid onset are used to elicit synchronous discharge of a large number of neurons occurring during the first 10 msec after the presentation of the stimulus.[6]

The clinical and experimental interest created by the discovery of these potentials is based on the presumed correlation of each peak with specific brainstem structures.[7]

The stability and reproduceability of the BAEP, especially peak latencies, make it potentially useful in diagnosing hearing disorders and detecting brainstem lesions, demyelinating diseases, and possibly dementia.[8]

The BAEP represents the early phases of the auditory evoked response and provide information about sensory functioning & integrity of the nervous system. The influences of subject factors, especially advanced age, on the BAEP gain experimental attention.

Fujikawa and Weber (1977), focusing on Wave V, found prolonged latency shifts from a 13 click/sec baseline response when older individuals were compared to young adults.[9]

Below the age of 2 years, interpeak latencies are prolonged relative to adult values.[10] By the age of 2 years, the ranges for adults are reached, the absolute latencies of wave I, III, V increase by

0.1-0.2 msec with age. The reason for the age-related latency shift is progressive myelination of the auditory tract.[11]

Aging changes (that is, increases in latency attributable to increased conduction time in older subjects) were observed in the brainstem auditory pathway. The results suggest that age-related changes in human sensory systems are not uniform, but rather are different in specific portions of these systems, different at particular epochs of the life span.[12]

Some of the changes that occur in the aging auditory system may significantly influence the interpretation of the auditory brainstem responses in comparison with younger adults.[13]

Since age effects on central conduction time in the acoustic pathway are still debated, so the aim of our study is to investigate the differences, in BAEP component latencies in different age groups.

2. Materials and Method:

In our study about seventy five normal healthy subjects were assigned to the following age groups:

1. 11-20 years (n=15)
2. 21-30 years (n=15)
3. 31-40 years (n=15)
4. 41-50 years (n=15)
5. 51-60 years (n=15)

BAEP test procedure was explained & written consent obtained from the subjects (> 18 years) or from the legal guardians of the subjects (< 18 years). A detailed history and thorough clinical & ENT examination were carried out to rule out any medical problem. Specific history was also taken to rule out any prolonged exposure to noise. Their height & weight were also taken. BAEP recording was done in a quiet air conditioned room (28 $\pm$ 1 ^{o}C). All the subjects were studied in the sitting position with appropriate head positioning so as to minimize postural muscle activity in the head & neck. The subjects were made to relax in order to minimize muscle artifacts. The recording surface electrodes filled with conductive paste were fixed on vertex (Cz, 10-20 international electrode placement system) & the on the mastoid process ipsilateral to the ear being stimulated. The ground electrode was placed on forehead (Fz). Electrodes were connected to the evoked potential recorder (RMS EMG. EP MARK II Machine manufactured by RMS recorder & medicare system, Chandigarh). Impedance of electrode was kept below 5 k ohms. A band pass of 100-3000 Hz was used to filter out undesirable frequencies in the surroundings. Responses to 2000 click presentation were averaged for 10 msec. Because of poor signal to noise ratio, it is necessary to average several hundreds of signal responses to get a recognizable BAEP waveform.[14]

2.1 Brainstem Auditory evoked Potential: The subject's hearing threshold was determined for each ear at the time of testing. The acoustic stimulus was rarefaction clicks, which were generated by passing 0.1 ms square pulses through shielded headphones. Clicks of intensity 60 dB above the hearing threshold were delivered at the rate of 10 pulses per second. Monaural stimulation was used & contralateral ear was masked by white noise at 30 dB below the click intensity. BAEP waves were identified & labelled. The peak latencies of waves I, II, III, IV & V were measured. The interpeak latencies I-III, I-V, III-V was computed. Amplitudes of waves were also measured from peak to following trough of the wave. The waveform measured between the vertex and the ear being stimulated constitutes the ipsilateral recording, whereas the waveform measured between the vertex & ear opposite of the ear being stimulated constitutes the contralateral recording.

3. Observation & Results:

The mean & standard deviation of the absolute peak latency and interpeak latency in milliseconds are shown in Table 1 & 2.

In our study, seventy five normoacoustic male subjects aged from 11-60 years were sampled. The recorded results are grouped according to patients age ranges of 11-20 (15), 21-30 (15), 31-40 (15), 41-50 (15) and 51-60 (15) years. The absolute peak latency of waves I, III & V and interpeak latency of wave's I-III, III-V & I-V in various age groups are analyzed.

The data collected from both ears showed that increase in age will cause an increase in peak latency and interpeak latency values of all waves. Increase in age from younger to older caused values of wave I, III & V absolute peak latencies and interpeak latencies increase accordingly.

The peak latencies & interpeak latencies from ipsilateral ears were lower than those from contrallateral ears. The mean values taken from mean peak latency values of waves I, III, V and interpeak latencies of I-III, III-V & I-V from contralateral ears are not very much prolonged compared to ipsilateral ears in all subjects & thus can be negligible.

3. Discussion:

The present study revealed that increase in age will cause an increase in peak latency and interpeak latency of all waves. There occurred significantly increased latencies of the waves I, III & V and interpeak latencies of the waves, I-III and I-V in older males as compared to the young males, thus showing that age affects these waves. The peak latency value of wave I in different age groups are 1.54 ms in 11-20 years, 1.62 ms in 21-30 years, 1.65 ms in 31-40 years, 1.65 ms in 41-50 years & 1.85 ms in 51-60 years age group. The peak latency value for wave III in different age groups are 3.50 ms in 11-20 years, 3.62 ms in 21-30 years, 3.67 ms in 31-40 years, 3.80 ms in 41-50 years & 3.93 ms in 51-60 years age group. The peak latency value for wave V of different age groups are 5.47 ms in 11-20 years, 5.60 ms in 21-30 years, 5.70 ms in 31-40 years, 5.73 ms in 41-50 years & 5.80 ms in 51-60 years age group.

Our study is comparable with the findings of previous one:

Rowe (1978) found all seven peaks of the BAEP increased in older than in young person's [15]. Jarger & Hall (1980), found peak latency value of wave V increase from younger to older subjects.[16] Stephen W H (1981), observed peak latency increases in the elderly, to be due to peripheral processes.[17] Nai-Shin Chu (1985), showed small progressive prolongation in the peak latency with increasing age, particularly peak V.[18] Rosenhall U *et al* (1985), found latencies of waves I, III and V increase 0.1-0.2 msec with increasing age.[19] Trune DR *et al* (1988), observed age was significantly correlated only with the latency of wave III.[20] Costa P *et al* (1990) found age-related prolongation of latency values particularly marked for wave I.[21] Fallah TM (2007), observed increase in age also increases the peak latencies value of waves I, III & V accordingly.[22] Harinder JS *et al* (2010), found the absolute peak latency of the waves III and V increased significantly from younger to older males.[23]

On the other hand, Beagley and Sheldrake (1978)[24], and Mogens Kjaer (1979)[25], T J Manjuran (1982)[26], Costa P *et al* (1990) and Lille F *et al* (1991)[27] found no significant age differences in BAER latencies between younger and older subjects.

We also found prolongation of I-III, III-V and I-V interpeak latencies as the age is increasing from younger to older & this finding is supported by Fallah TM (2007), showed increasing trend in age from younger to older caused values of interpeak latencies I-III, III-V & I-V increase accordingly similarity was noted with Harinder J S (2010) for I-III & I-V IPLs but no significant difference for waves III-V interpeak latency whereas Rowe (1978) reported increased wave I-III interpeak latency in older than in young persons. This finding is contradicted by Nai-Shin Chu (1985), observed no significant correlation between the age and the I-III IPL but reported small increase in III-V and I-V IPL with age.

On the other hand, Stephen WH (1981) found interpeak latencies were equivalent in the two age groups. Rosenhall U *et al* (1985) noted the I-V IPL remains the same in all age groups. Costa P *et al*, (1990) noted that interpeak latency values do not increase with increasing age, in particular IPL I-II and I-III decrease, showing a negative r value, and IPL I-V and II-V do not show a significant change. So, he concluded that the aging process is essentially a peripheral phenomenon which does not involve the central part of the acoustic pathway.

We present with increased latency and the interpeak latency 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 BAEPs.[23]

Our study indicates that the variation in I-III interpeak latency is comparatively larger in value than III-V and I-V interpeak latencies from both ipsilateral & contralateral ear. The mean difference between the two interpeak latency values of younger & older age groups in both ears is a little larger than normal. The I-III IPL values from ipsilateral ears of younger & older age groups were 1.97 & 2.08 ms respectively while the corresponding values in contralateral ear were 1.80 & 2.04 ms respectively. Prasher DK (1980) showed that significant latency differences exist between ipsilateral and contralateral stimulation. He concluded that different neural pathways are followed by ipsilateral and contralateral stimuli & that their respective responses can be investigated separately in man using BAEP recordings.[28]

Our study shows no significant differences in the wave's latencies between tall and short subjects & this is in accordance with the Kjaer M, 1979 and T J. Manjuran, 1982.

The number of significant correlation in the predicted direction was less than would be expected from chance alone. It is not unreasonable to suggest, therefore, (1) that the age differences that were found are not solely the result of ageing processes at the receptor organ, and (2) that changes in transmission or neuronal propagation within the brainstem may contribute to these age differences.

Since it appears that age differences occur predominantly at wave III, a question can be raised regarding the possibility of differential changes with respect to age in the various structures of the auditory auditory system, particularly at the level of the olivary complex, & beyond, that would correspond to the age differences seen in the BAEP.

Our study concludes that there occurred statistically significant variations with age in the Brainstem auditory evoked potentials. Significant changes in the BAEPs in our study support the possible role of age as contributory factors for normal variations.

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Table – 1 Mean absolute peak latency values in ipsilateral & contralateral ears

Peak Latencies (ms)	Age Groups	Ipsilateral Ear	Contralateral Ear
I	11-20 (n=15)	1.54 ± 0.006 (p <0.001)	1.73 ± 0.271 (p <0.0001)
	21-30(n=15)	1.62 ± 0.049 (p < 0.001)	1.75 ± 0.135 (p<0.001)
	31-40(n=15)	1.65 ± 0.011 (p < 0.0015)	1.83 ± 0.232 (p <0.01)
	41-50(n=15)	1.65 ± 0.013 (p< 0.0001)	1.80 ± 0.096 (p < 0.001
	51-60(n=15)	1.85 ± 0.035 (p < 0.001)	1.89 ± 0.151 (p < 0.001)
III	11-20(n=15)	3.50 ± 0.154 (p < 0.0016)	3.52 ± 0.129 (p < 0.0016)
	21-30(n=15)	3.62 ± 0.069 (p < 0.004)	3.65 ± 0.020 (p < 0.004)
	31-40(n=15)	3.67 ± 0.013 (p < 0.003)	3.70 ± 0.043 (P < 0.001)
	41-50(n=15)	3.80 ± 0.120 (p < 0.002)	3.85 ± 0.071 (p < 0.001)
	51-60(n=15)	3.93 ± 0.038 (P < 0.001)	3.93 ± 0.072 (p < 0.005)
V	11-20(n=15)	5.47 ± 0.082 (p < 0.0016)	5.67 ± 0.095 (p < 0.004)
	21-30(n=15)	5.60 ± 0.022 (p < 0.001)	5.70 ± 0.019 (p < 0.00)
	31-40(n=15)	5.70 ± 0.028 (p < 0.004)	5.82 ± 0.034 (p < 0.006)
	41-50(n=15)	5.73 ± 0.030 (p < 0.001)	5.83 ± 0.053 (p < 0.001)
	51-60(n=15)	5.80 ± 0.073 (p < 0.001)	5.83 ± 0.083 (p < 0.004)

Table – 2 Mean interpeak latency values in ipsilateral & contralateral ears

Interpeak Latencies (ms)	Age Groups	Ipsilateral Ear	Contralateral Ear
I-III	11-20(n=15)	1.97 ± 0.149 (p < 0.001)	1.80 ± 0.143 (p < 0.004)
	21-30(n=15)	2.01 ± 0.021 (p < 0.002)	1.91 ± 0.116 (p < 0.001)
	31-40(n=15)	2.02 ± 0.107 (p < 0.004)	1.87 ± 0.189 (p <0.002)
	41-50(n=15)	2.13 ± 0.001 (p < 0.004)	2.03 ± 0.023 (p < 0.001)
	51-60(n=15)	2.08 ± 0.148 (p < 0.004)	2.04 ± 0.079 (p < 0.01)
III-V	11-20(n=15)	1.98 ± 0.073 (p < 0.00)	2.16 ± 0.035 (p < 0.002)
	21-30(n=15)	1.99 ± 0.048 (p < 0.004)	2.06 ± 0.002 (p < 0.001)
	31-40(n=15)	2.03 ± 0.015 (p < 0.002)	2.12 ± 0.009 (p < 0.006)
	41-50(n=15)	1.91 ± 0.088 (p < 0.001)	1.96 ± 0.016 (p < 0.002)
	51-60(n=15)	1.87 ± 0.035 (p < 0.004)	1.90 ± 0.010 (p < 0.002)
I-V	11-20(n=15)	3.94 ± 0.028 (p < 0.00)	3.95 ± 0.177 (p < 0.001)
	21-30(n=15)	3.99 ± 0.077 (p < 0.002)	3.96 ± 0.117 (p < 0.001)
	31-40(n=15)	4.05 ± 0.017 (p < 0.004)	3.99 ± 0.198 (p < 0.00)
	41-50(n=15)	4.06 ± 0.015 (p < 0.002)	4.01 ± 0.041 (p < 0.001)
	51-60(n=15)	3.95 ± 0.038 (p < 0.001)	3.91 ± 0.068 (p < 0.001)

P value < 0.001 HS (Highly Significant)
P value < 0.005 S (Significant)
P value > 0.005 NS (Non Significant)