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The Study Of Age And Sex Related Changes In The Brainstem Auditory Evoked Potential

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ABSTRACT

Auditory evoked potential responses were recorded in 150 normal healthy subjects of different age groups (G1 = 15-29 years, G2 = 30-45 years, G3 = 46 years onwards), with a matched number of males and females in each group. These potentials were recorded by using EEG electrodes on an RMS EMG, EP MARC II (PC-based) machine. The data was statistically compared between the different age groups and between the males and females and regression analysis was done. Absolute latencies of the waves III, IV and V and the interpeak latency of the waves, I-III and I-V showed significant increase with age, thus suggesting degenerative changes in the auditory pathway and synaptic delay. There were significantly increased values of the latencies of the waves III, IV and V and interpeak latencies of the waves, I-III, I-V and III-V in males as compared to the females. Thus, age and sex have an effect on latency and interpeak latency in Brainstem auditory evoked potentials.

Key words: Auditory evoked potential, Interpeak latency.

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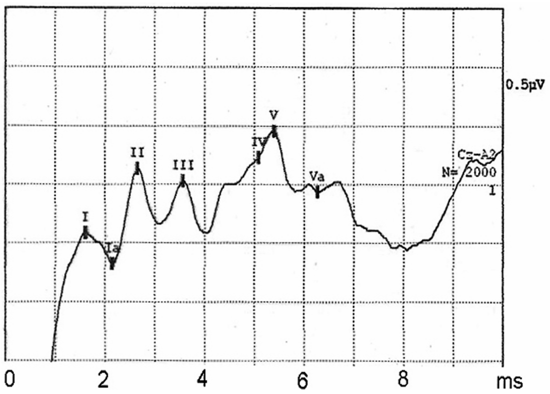
INTRODUCTION

Auditory evoked potentials (AEPs) are very small electrical voltage potentials which originate from the brain and are recorded from the scalp in response to an auditory stimulus [1],[Table/Fig I]. They are recorded within 10 ms after the sound stimulus and are called as Short latency responses [2]. These are also known as Brainstem auditory evoked potentials (BAEPs) or Brainstem evoked responses (BSERs) [3]. These waves represent the neuroelectrical activity which is generated by the neural generators in the auditory pathway between the cochlea and the brainstem. These waves are generated at the following points of the auditory pathway: Wave I- Cochlear nerve, Wave II- Cochlear nuclei, Wave III- Superior olivary nucleus, Wave-IV- Lateral leminiscus and Wave V- Inferior collicus. ***

AEP is affected by factors like age, gender, head size and hearing loss. The absolute peak latencies of the AEP waves increase with an increase in age. The waves I, III, and V have a direct influence on age. [4]. Also, the interpeak latencies (IPLs) of the waves I-III, III-V and III-V in the older age groups had an increased value as compared to that in young people [5]. The latencies of the waves I, III, and V increased by 0.1 to 0.2 ms with increasing age [6]. The latencies and interpeak latencies were found to be prolonged with aging, thus suggesting the slowing of the processing within the aging auditory system.

There also occurred gender differences of these waves. Males were found to have 0.1 to 0.2 ms longer latencies of the waves III and V and longer I–V interpeak intervals than females. The sources of the male and female related differences could be factors such as head size or gender-dependent sizes of the external acoustic meatus.

[Table/Fig 1]: Normal tracing of ABR waves.



MATERIAL AND METHODS

This study was conducted in the Department of Physiology, Government Medical College, Amritsar. Subjects comprising of 3 different age groups were selected. Each group was divided equally into 25 male and 25 female subjects. G-1a: Males of the age group 15-29 years**.** G-1b: Females of the age group 15-29 years. G-2a: Males of the age group 30-44 years. G-2b: Females of the age group 30-44 years. G-3a: Males of the age group 45 years and above. G- 3b: Females of the age group 45 years and above.

All the subjects were without a history of neurological and audiological problems and were free from any medication at the time of recording. A detailed history was taken and general physical examination was done in all these subjects. The Rinnie Test and the Weber test were done to rule out any abnormality of hearing defects.

Recording Technique

The test which was performed on these subjects was BERA, by using an RMS, EMG, EP MARC–II Ch (PC based) machine and EEG electrodes. The ground electrode was placed at the Fz position on the forehead above the nasion. The reference electrode was placed on the vertex Cz and the active electrodes were placed on the left mastoid and the right mastoid of each ear. The electrode impedance was kept below 5 Kohm. The procedure was explained to the subjects and a written consent was signed by them. The subjects were lying on a bed and were asked to relax completely. The intensity of the light in the room was dimmed and unnecessary movement was kept to a minimum. In case of the female subjects, they were asked to remove ear-rings and other metallic ornaments.

The amplication and the audiometric threshold

Brainstem auditory evoked potentials were produced by a brief click which stimulated the head phones. The clicks were given at the rate of 11.1 per second. The recordings were averaged and superimposed by using computer techniques. The clicks were given at an intensity of 60 db sound level above the individual perceptual hearing threshold. The individual perceptual thresholds were estimated by using the method of ascending and descending limits, with increment and decrement intervals of 1 db sound level. Low filter setting was kept at 5 Hz and high filter setting was kept at 3000Hz.

The amplified waves were displaced on the computer screen and they were digitalized and averaged by using a PC based BERA machine and prints of the recording were taken. A series of 5 waves were recorded during the first 10 ms, following the sound stimulus. The absolute latencies of the waves I to V and the interpeak latencies between the waves, I-III, I-V and III-V were recorded for both the right and left ears. The data was analysed statistically by using the Student's unpaired't' test. A regression analysis was done by using Pearson's correlation coefficients, by taking age and sex as independent variables.

RESULTS

The mean and standard deviation of the absolute peak latency and interpeak latency in milliseconds are shown in [Table/Fig **2**].

[Table/Fig 2]: Comparison of values of BAEPs between G-1a (young males) and G-3a (older males)

Absolute peak latency (APLs)	Young Males	older males	p-value
I	1.70 ± 0.19	1.67 ± 0.21	0.600; NS
II	2.74 ± 0.18	2.71 ± 0.22	0.600; NS
III	3.23 ± 0.26	3.80 ± 0.13	<0.001; HS
IV	4.85 ± 0.28	4.86 ± 0.19	0.880; NS
V	5.62 ± 0.26	5.84 ± 0.27	0.005; S
Interpeak latency (IPL)			
I-III	1.90 ± 0.22	2.22 ± 0.15	<0.001; HS
I-V	3.88 ± 0.36	4.36 ± 0.27	<0.001; HS
III-V	1.98 ± 0.36	2.14 ± 0.27	0.080; NS

NS: Not Significant; S: Significant; HS: Highly Significant

The absolute peak latency of the waves III and V and the interpeak latencies of the waves, I-III and I-V were significantly increased in older males (G-3a) than in younger males (G-1a). No significant differences were found in the absolute latencies of the waves I, II and IV and the interpeak latencies of the waves III-V.

[Table/Fig 3] shows statistically significant differences in the latency of waves III and IV, when young females (G-1b) were compared with older females (G-3b), while no significant differences was observed in the absolute latencies of the waves I, II, V and the interpeak latencies of the waves I-III, I-V and III-V.

[Table/Fig 3]: Comparison of values of BAEPs between G-1b (young females) and G-3b (older females)

Absolute peak latency (APLs)	Young Females	Older Females	p-value
I	1.62 ± 0.13	1.70 ± 0.21	0.110; NS
II	2.78 ± 0.15	2.79 ± 0.23	0.860; NS
III	3.22 ± 0.16	3.68 ± 0.16	<0.001; HS
IV	4.71 ± 0.14	4.89 ± 0.16	0.0001; HS
V	5.59±0.24	5.62±0.24	0.660; NS
Interpeak latency (IPL)			
I-III	2.01 ± 0.25	1.99 ± 0.23	0.770; NS
I-V	3.97 ± 0.25	3.92 ± 0.37	0.580; NS
III-V	2.00 ± 0.38	1.90 ± 0.29	0.300; NS

NS: Not Significant; S: Significant; HS: Highly Significant

[Table/Fig 4] shows that females displayed larger BAEPs for waves I, II and IV, but the difference was not significant. The only latency differences which reached significance were the latencies of waves III and V, with higher values in males as compared to the females. Also, the interpeak latencies of the waves I-III and I-V had a significantly increased value in males (G-3a) than in the females (G-3c).

[Table/Fig 4]: Comparison of values of BAEPs between G-3a (old aged males) and G-3b (old aged females)

Absolute peak latency (APLs)	Males	Females	p-value
I	1.67 ± 0.21	1.70 ± 0.21	0.620; NS
II	2.71 ± 0.22	2.79 ± 0.23	0.220; NS
III	3.80 ± 0.13	3.68 ± 0.16	0.005; S
IV	4.86 ± 0.19	4.89 ± 0.16	0.550; NS
V	5.84±0.27	5.62±0.24	0.004; S
Interpeak latency (IPL)			
I-III	2.22 ± 0.15	1.99 ± 0.23	<0.001; HS
I-V	4.36 ± 0.27	3.92 ± 0.37	<0.001; HS
III-V	2.14 ± 0.27	1.90 ± 0.29	0.004; S

NS: Not Significant; S: Significant; HS; Highly Significant

[Table/Fig 5] shows the regression analysis of BAEP, by taking age and sex as independent variables, which shows that there occurred a positive correlation between the latencies of the waves III, IV and V and age and between the interpeak latencies of the waves I-III, III-V and I-V and age in all the subjects.

[Table/Fig 5]: Table showing regression analysis of BAEP taking age and sex as independent variable

Latency	Males	Females	All subjects
APL I	Y = 1.710 - 0.0008 (X)	Y = 1.567 + 0.002 (X)	Y = 1.631 + 0.001 (X)
APL II	Y= 2.776 - 0.001 (X)	Y = 1.567 + 0.002 (X)	Y = 2.776 - 0.0007 (X)
APL III	Y = 4.367 + 0.042 (X)	Y = 3.548 + 0.003 (X)	Y = 4.055 + 0.020 (X)
APL IV	Y = 4.841 + 0.001 (X)	Y = 4.841 + 0.001 (X)	Y = 4.734 + 0.002 (X)
APL V	Y = 5.452 + 0.007 (X)	Y = 5.452 + 0.007 (X)	Y = 5.522 + 0.003 (X)
IPL I-III	Y = 1.842 + 0.004 (X)	Y = 1.842 + 0.004 (X)	Y = 1.932 + 0.001 (X)
IPL I- V	Y = 3.883 + 0.003 (X)	Y = 3.707 + 0.009 (X)	Y = 3.883 + 0.003 (X)
IPL III-V	Y = 1.984 + 0.0004 (X)	Y = 1.863 + 0.005 (X)	Y = 1.984 + 0.0004 (X)

Where 'X' is age in years and 'Y' is latency in milliseconds

DISCUSSION

The present study revealed that there were changes in the absolute latencies and interpeak latencies with age and gender**.** There occurred significantly increased latencies of the waves III and 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 [Table/Fig I]. The latency of wave V was 5.62 in young males and 5.84 in older males. This finding is comparable to a recent study which was conducted in 2007, which showed the change in the latency of wave V from 5.46 to 5.80 with advance in age. [5].

In this study, when the latency of wave III in G-3 b (old females) (3.68 ± 0.16) was compared with G-1b (young females) (3.22 ± 0.16), the difference was found to be highly significant [Table/Fig II], showing again the increase in the wave latency with age. Also, the latency of wave IV showed an increasing trend with age i.e. 4.89 ± 0.16 in older females and 4.71 ± 0.14 in young females. An earlier study on auditory evoked potentials, which was conducted by Lopez Escamez et al (1999), showed similar results [9]. But in a previous study, only the latencies of the waves I, III and

V were analyzed. Our study showed that the increased absolute latencies for wave IV were related to age and they also showed a positive correlation with age.

Our statistical analysis showed that the mean latencies of wave I and II and the interpeak latencies of the waves III-V did not show significant differences with age [Table/Fig I and II]. This observation was at variance with the findings of the study conducted by Stuzebecher E et al (1987), which showed that the wave latency I and II and the interpeak latencies of the waves III-V showed statistically significant differences between males and females [4].
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 BAEPs [7].

The latency prolongation of the ABR components showed that the cognitive processing was affected with aging. Cognitive alterations which were observed with aging have been related to the dopaminergic and the cholinergic systems which play an important role in the process of cognition, because the number of mascarinic Ach receptors in the central nervous system and the activity of choline acetyltransferase in the nerve terminals were shown to decrease with aging. On the other hand, nigrostriatal axons, nigrostriatal dopaminergic neurons and strial endogenous dopaminergic concentration in the human brain and in the D_2 dopamine receptor binding sites were found to decrease with age. So, the cognitive decline is found to have been caused by the deterioration of the dopaminergic and the cholinergic systems [9]. Thus, cognitive decline occurs as age advances, which may be the reason for the changes in the BAEPs as age advances.

[Table/Fig III] shows the increases latency of the waves III and V and the increased values of the interpeak latencies of the waves I-III, III-V and I-V in males as compared to the females, thus showing the gender effects of the BAEPs.

The interpeak latency I-III (which is the measure of the conduction time from the VIIIth nerve across the subarachnoid space into the core of the lower pons) [10] and the interpeak latency I-V (which is a measure of conduction from the proximal VIIIth nerve through the pons to the midbrain) [10] showed increased values in males as compared to the females of the same age group. The reduction of wave latencies and interpeak latencies in females than in males could be due to skull size and differences in the hormones and the core body temperature [11].

[Table/Fig IV] shows the regression analysis of BAEP with age. Our study also showed that there occurred a positive correlation between the latencies of the waves III, IV and V and age and between and interpeak latencies of the waves I-III, III-V and I-V and age, both in males and in females. These predictive models can be utilized to estimate the wave latencies and their regression with age.

Hence, our study concludes that there occurred statistically significant variations with age and sex in the Brainstem auditory evoked potentials. The changes with age were more in the latencies of the waves III, IV and V and the interpeak latencies of the waves I-III, I-V and III-V. Our study also revealed that females showed significantly decreased values of the latencies of the waves III and V and interpeak latencies of the waves, I-III, III-V and I-V.

Significant changes in the BAEPs in our study support the possible role of age and gender as contributive factors for normal variations. Auditory evoked potential wave latencies and inter peak latencies have important diagnostic values. The interpretative accuracy of the evaluation of the BAEPs can be enhanced only when these normal variations are taken into consideration with relevant case history information.

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