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EFFECT OF GENDER ON BRAINSTEM AUDITORY EVOKED POTENTIAL

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ABSTRACT

The most constant and most important BAEP waves from the clinical point of view are waves I, III & V. Their measurements include absolute latency and interpeak latency. The Interpeak latencies represent conduction time through relay stations of auditory pathway in the brainstem. Thus IPL I-III is a measure of conduction from acoustic nerve to pontomedullary region, III-V conduction in the more rostral pontine and midbrain portion of the pathway and I-V reflects the total brainstem conduction time. Concerning electrophysiological measures, it appears that at least for middle and late evoked potentials male and female differences appear in adulthood. There appears to be less agreement among researchers with respect to the age at which gender differences are evident with the auditory brainstem response. The aim of our study is to find out the effect of gender on BAEP waves latencies and amplitudes. We assigned one hundred and five subjects for study. Out of them 55 were males and 50 females between the age group of 20-35 years. Wave III and wave V latencies & I-III and I-V interpeak latencies were significantly ($P < 0.01$) shorter in females than in males. The difference in mean wave V latency between males & females was 0.18 ms. The significant changes in the BAEPs in our study support the possible role of gender as contributive factors for normal variations.

KEY WORDS: Brainstem auditory evoked potential, latency, interpeak latency, male, female.

INTRODUCTION

Significant effects of age and gender are evidenced in essentially all dimension of auditory function in adults. For example, hearing sensitivity is significantly better in females than males. Speech recognition in quiet and in competition is also generally superior in females. Tympanometry indicants also differ among males and females. Differences are demonstrated between the genders & in otoacoustic emissions including both spontaneous and evoked (1). Males are better at sound localization, detecting binaural beats, and detecting signals in complex masking tasks than are females (2).

With respect to electrophysiological measures, the differences are documented in early and late evoked potentials. Although gender differences are universally observed, the developmental stages at which these differences are evident vary across indices of auditory function. For example, male and female variances in hearing sensitivity are observed typically after the third decade of life. Differences in middle ear function are apparent in the third decade of life (1).

Concerning electrophysiological measures, it appears that at least for middle and late evoked potentials male and female differences appear in adulthood (3). There appears to be less agreement among researchers with respect to the age at which gender differences are evident with the auditory brainstem response.

Clinical stimuli delivered to one or both ears evoke seven submicrovolt vertex-positive waves in the first 10 msec after each stimulus (4). They are named according to their sequence in roman letters from I to VII (5). These waves represent their source of origin from auditory nerve (wave I), cochlear nuclei (wave II), superior olive (wave III) and lateral lemeniscus & inferior olivary nucleus (wave IV-V complex). Waves VI and VII are not found in all normal subjects. They are generated in medial geniculate body and auditory radiation from the thalamus to temporal cortex respectively (6). The most constant and most important waves from the clinical point of view are waves I, III & V (7). Their measurements include absolute latency (stimulus to peak) and interpeak latency (time interval between the peaks). The clinical interpretation is based on the interpeak latencies (IPLs). The IPLs represent conduction time through these relay stations of auditory pathway in the brainstem. Thus IPL I-III is a measure of conduction from acoustic nerve to pontomedullary region, III-V conduction in the more rostral pontine and midbrain portion of the pathway and I-V reflects the total brainstem conduction time (8). Absolute amplitudes are extremely variable in normal subjects (9).

The BAEP wave latencies and conduction time regularly change during the first two year of child's life due to myelination in auditory pathway. In calculating references values, the temporal characteristics of the main BAEP wave's I-V are assumed to reach definite values at the age of three

Figure 1: Anatomical-electrophysiological correlation of BAEP (11)

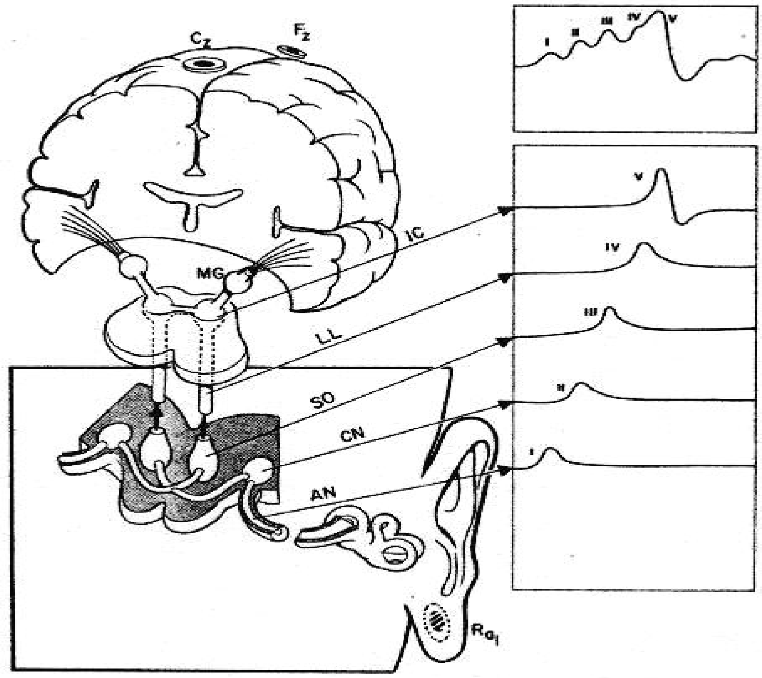


Figure 93. **Auditory evoked response studies. AN = auditory nerves; CN = cochlear nuclei; SO = superior olives; LI = lateral lemnisci; IC = inferior colliculi; MG = medial geniculates.**

years. At the same time, the BAEP wave amplitudes may gradually increases at an age of four or five years and then slightly decrease. The transition to adulthood entails changes such as an increase in latencies & IPL and decrease in the amplitudes of BAEP waves.

Data on sex related differences in BAEPs are contradictory; however the individual wave latencies and IPL to be shorter & the BAEP wave amplitudes to be greater in women than in men. The period of adolescence, during which sex related differences in BAEPs may appear or increase studied poorly (10). So, the aim of our study is to find out the effect of gender on BAEP waves latencies and amplitudes.

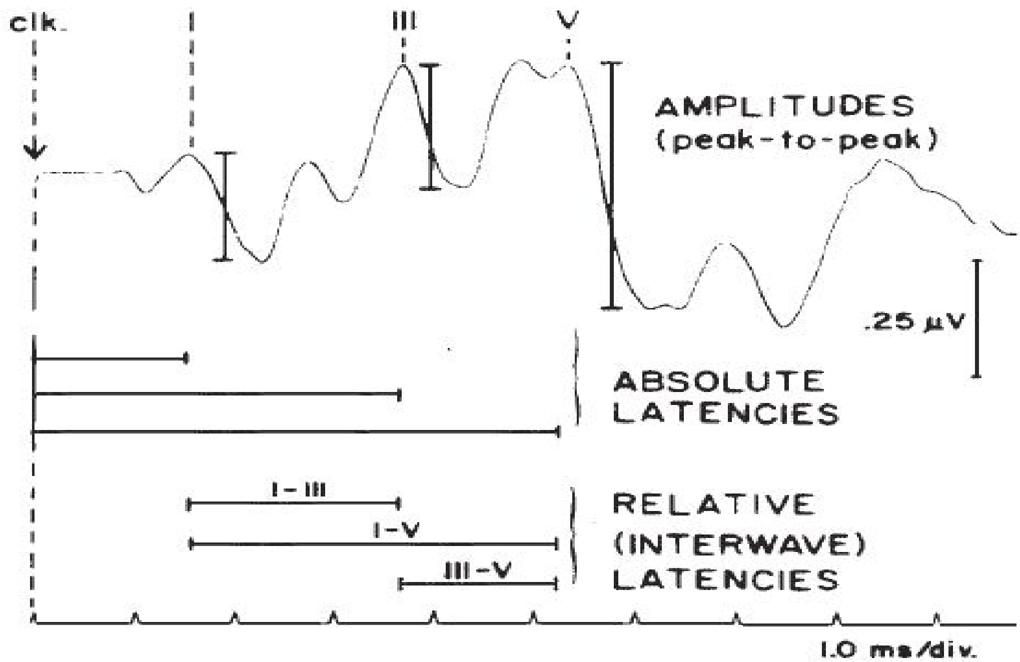
MATERIALS AND METHODS:

In our study about one hundred and five normal healthy subjects between the 20-35 years age groups were assigned. BAEP test procedure was explained & written consent obtained from the subjects. Detailed history and thorough clinical & ENT examination were carried out to rule out any medical problem. The Rinnie Test and Weber test were done to rule out any abnormality of hearing defects. Specific history was also taken to rule out any prolonged exposure to noise. BAEP recording was done in a quiet air conditioned room (28 $\pm$ 1 ^{o}C). The subjects were made to relax in order to minimize muscle artifacts. In case of the female subjects, they were asked to remove ear rings and other metallic ornaments. The recording surface electrodes filled with conductive paste were fixed on vertex (Cz, 10-20 international electrode placement system) & the on the mastoid process. 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. Low filter setting was kept at 100 Hz and high filter setting was kept at 3000Hz. Responses to 2000 click presentation were averaged for 10 msec**.**

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.

Figure 2: Basic amplitude & latency measures of the ABR (12)



RESULTS

We assigned one hundred and five subjects for study. Out of them 55 were males and 50 females between the age group of 20-35 years. The mean age for male is 26.9 ± 2.8 (mean ± SD) and for female 22.4 ± 2.4 (mean ± SD) years. The mean and standard deviation of the absolute peak latency and interpeak latency in milliseconds in male & female are shown in Table 1.

Table 1: Absolute peak latency & interpeak latency in male & female:

	I	III	V	I-III	III-V	I-V
Female	1.50 ± 0.09	3.56 ± 0.15	5.45 ± 0.17	2.17 ± 0.14	1.81 ± 0.12	3.94 ± 0.17
Male	1.52 ± 0.1	3.65 ± 0.15	5.62 ± 0.17	2.26 ± 0.13	1.88 ± 0.11	4.9 ± 0.15

Table 1 list the mean and standard deviation of absolute wave latencies & interpeak latencies in msec for male & female. Although no difference in wave I and III-V IPL were detected between males and females. Wave III and wave V latencies & I-III and I-V interpeak latencies were significantly ($P < 0.01$) shorter in females than in males. The difference in mean wave V latency between males & females was 0.15 ms.

The amplitudes of BAEP waves (wave I & V) showed high degree of variation and thus the amplitude values could not be compared statistically.

DISCUSSION

The latencies of waves III & V and interpeak latencies I-III and I-V are significantly higher in male as compared to female. Females have shorter interpeak latencies than males. This may be explained by shorter corresponding segments of the auditory pathway due to smaller brain size in female (13). Aging changes that is, increases in latency attributable to increased conduction time in older subjects were observed in brainstem auditory pathway and males tended to show larger aging effects than females (14). Our study is suppoted by Aoyagi M et al (1990) & Harinder J S et al (2010). Aoyagi M et al (1990) investigated ABR latencies in 107 adults (57 males and 50 females) with normal hearing & found Wave III and wave V latencies and I-III and I-V interpeak latency intervals were significantly shorter in females than in males. He obtained significant positive correlations between head size and above-mentioned ABR wave latencies and IPLs. These results suggest that head size, which may reflect brain size, is one of the important factors for the basis of gender difference in ABR latencies (15). Harinder J S et al (2010) found BAEP waves III and V and interpeak latencies I-III and I-V are significantly higher in male as compared to female (16).

Our study is comparable by previous other studies:
Mogens K (1979) showed that the male subjects have significantly large latencies for the waves III-VII ($p < 0.0005$) & the elongation increasing from 0.09 to 0.44 msec from wave III to VII. The female subjects have amplitudes significantly higher than male subjects, although the variations are very wide (17).

Michalewski et al (1980) displayed consistently larger BAEPs for waves IV, V, VI and VII in females than males. The females showed significantly shorter wave V latencies than the males. Differences in the relative distances of the anatomical generators are considered in accounting for the sex differences (18). Julie V Patterson et al (1981) noted significant sex effects that the females had shorter Wave IV and V latencies than males (19).

T J Manjuran (1982) showed that females have significantly shorter waves I to VI latencies than males and the shortening increased progressively from wave I to VI. Amplitudes showed a very wide range of variations in both sexes with significant overlapping & not significant (20).

Nai-Shin Chu (1985) found that I-VII peak latencies and I-III, III-V and I-V IPLs were consistently shorter for the female than the male with higher peak amplitude in female than the males (21).

Jacques Thivierge (1987) found that there was significant sex effect on the I–III IPL (22).

Dennis R Trune (1988), found that genders were significantly correlated with the latencies and amplitudes of waves I, III, and V and the I–V and III–V interpeak intervals. Males had longer latencies than females (23).

Y W Chan et al (1988) studied the effects of sex and click polarity on the BAEP latencies and amplitudes & found females had shorter absolute and interpeak latencies and higher absolute amplitudes than the males. These sex-related BAEP differences were independent of the click polarity (24).

Christopher P et al (1990) studied 10 young women and 10 young men. He confirmed significant gender differences between men's and women's auditory brainstem responses with longer latencies and smaller amplitudes in men than women (25).

Lille F (1991) found a gender differential aging process for some of the short-latency somatosensory evoked potentials (26).

V P Rozhkov (2009) investigated 4-14 years age groups of students & found interpeak intervals I–III, Andrew Stuart & Edward Y Yang. Effect of gender on auditory brainstem response latencies and thresholds to air & bone conducted clicks in newborn infants. Department of Communication Sciences and Disorders. East Carolina University, Greenville, NC, 27858-4353 USA.
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III–V, and I–V that characterize the peripheral and central conduction times were shorter in girls than in boys. The BAEP characteristics in the subjects examined included shorter peak latency and a greater amplitude of wave I (except senior students), relatively prolonged interpeak interval I–III, and more pronounced sex-related differences in BAEPs, especially at puberty (10).

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) and the interpeak latency I-V (which is a measure of conduction from the proximal VIIIth nerve through the pons to the midbrain) (27) showed increased values in males as compared to the females. 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 (28).
The hormones after puberty may influence the conduction velocity of nerve impulses & release of neurotransmitter at synapses. Stat Hirsch et al reported that testosterone increases the latencies of BAEPs. The increased level of estrogen during pregnancy was found to alter the conduction in the auditory pathway (29). 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.

Increased I-III interpeak latency indicates a lesion from CN VIII to the superior olivary nucleus, while increased III-V interpeak latency suggests a lesion from the superior olivary nucleus to the inferior colliculus ipsilateral to the ear stimulated. Intraoperative monitoring during cerebellopontine angle tumor surgery may be helpful in aiding the surgeon to preserve as much function as possible (30).

In conclusion, significant changes in the BAEPs in our study support the possible role of gender as contributive factors for normal variations. The recorded BAEPs are non invasive measures of the subcortical auditory pathway's functional integrity and its wave latencies and interpeak latencies have important diagnostic values.

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