RESEARCH ARTICLE

Effect of Female Sex Hormones on Central Auditory Conductivity in Young Rural Females in Bathinda District of Punjab

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ABSTRACT

Background: The auditory, olfactory and taste thresholds get modified by changes in gonadal function. Auditory brainstem responses vary with age and sex of the individual. Auditory acquity also varies with the phase of menstrual cycle.

Aims & Objective: To study the effects of cyclical changes of endogenous sex hormones in different phases of menstrual cycle on Brainstem Auditory Evoked Responses.

Materials and Methods: The brainstem auditory conduction (BAEPs) recording was done in normal 40 healthy regular menstruating females in age group 19-23 years during three phases of same menstrual cycle. Phase 1:1-3 days with lowest level of oestrogen and progesterone, Phase 2:11-14 days with peak level of β-oestradiol and Phase 3:17-23 days with peak level of progesterone. Absolute latencies of I, III & V waves and interpeak latencies (IPL) of waves I-III, I-V and III-V were recorded in three phases of menstrual cycle and compared statistically.

Results: The comparison showed a statistically significant increase in absolute latencies of I, III & V waves in phase 2 compared to phase 1 and a statistical significant decrease in their values in Phase 3 compared to Phase 2. However, the variation in interpeak latencies I-III, I-V and III-V showed insignificant variation.

Conclusion: The study showed that variation of hormones during menstrual cycle affect the central auditory conductivity in young rural females.

KEY WORDS: Absolute Latencies; IPL; 17-β-Oestradiol; BAEP

INTRODUCTION

Female hormones undergo quantitative changes during critical periods of their life i.e. menstrual cycle, pregnancy and menopause. The menstrual cycle is a time of many widespread changes affecting both body and mind.[1] The menstrual cycle influences different clinical conditions such as atopic dermatitis diabetes, asthma, rheumatoid arthritis, pulmonary edema, cardiac arrhythmias & gastrointestinal dysfunctions.[2,3] EEG also varies during different phases of menstrual cycle with increase in α wave frequency at the time of ovulation.[4] The auditory, olfactory and taste thresholds get modified by changes in gonadal function.[5]

Auditory Brainstem Response (ABR) represent volume conducted electrical activity from auditory nerve to inferior colliculus in midbrain. These small electrical voltage potentials can be recorded from the scalp in response to an auditory stimulus and are known as Auditory evoked potentials (AEPs). 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.[6] Auditory brainstem responses vary with age and sex of the individual.[7] Auditory acquity also varies with the phase of menstrual cycle.[8] Some authors have reported delayed conduction during mid- cycle and faster conduction during mid-luteal phase[9,10] while others have reported no change across the menstrual cycle.[11,12] IN spite of several reports on the effect of sex hormones on auditory pathway in other parts of the country however, there are no reports from this region and none of the earlier studies have been done on rural population. Hence, the present study was done in young rural females of Bhucco Khurd village of Bathinda district of Punjab.

MATERIALS AND METHODS

The present study was conducted in Department of Physiology, Adesh Institute of Medical Sciences & Research, Bathinda after clearance from local ethical committee. The study was conducted on 40 female subjects in the age group 19-23 years. The female attendants coming from nearby villages and their healthy female relatives were taken for study. A detailed history was taken and general physical examination was done in all subjects. The Rinnie Test and the Weber test were done to rule out any abnormality of hearing defects. All had hearing threshold of 0-20 dBHL or better octave interval frequencies from 250-8000 Hz. Only females with normal body weight (body mass index between 18 and 25 kg/m^2), having no chronic illness (with the exception of allergies), or any other neurological, psychiatric or endocrinological illnesses were included in the study. Females experiencing irregular cycles, taking hormonal contraceptives or neuroactive sustbances, having diagnosed premenstrual syndrome, and having subjective hearing problems were excluded from the study. A retrospective calculation of the approximate day of ovulation was done from the day of onset of the next menstrual cycle. If any discrepancy was found, then that cycle was excluded from the study. The procedure was explained to the subjects and a written informed consent was taken from them. During their menstrual cycles, each woman underwent three ABR tests, the first at the menstrual phase (1-3 day), the second at the mid-cycle (11-14 day), the third at the secretory phase (17-23 day).

Brainstem Auditory Evoked Responses BERA was performed using an Octopus EMG/EP/NCS II Channel (PC based) machine and EEG electrodes. The subjects were lying on a bed and were asked to relax completely. The subjects were asked to remove ear-rings and other metallic ornaments. The intensity of the light in the room was dimmed and unnecessary movements were kept to a minimum. The ground electrode was placed at the 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. Brainstem auditory evoked potentials were produced by a brief click which stimulated the head phones. The clicks were given at an intensity of 60 db sound level above the individual perceptual hearing threshold at the rate of 11.1 per second. Low filter setting was kept at 5 Hz and high filter setting was kept at 3000Hz. The recordings were averaged and superimposed by using computer techniques. 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. The absolute latencies of the waves I, III & V and the interpeak latencies between the waves, I-III, I-V and III-V were recorded for both the right and left ears. Average of latencies from ABR waveform collected from both ears. The data was analyzed statistically by using the paired 't' test.

RESULTS

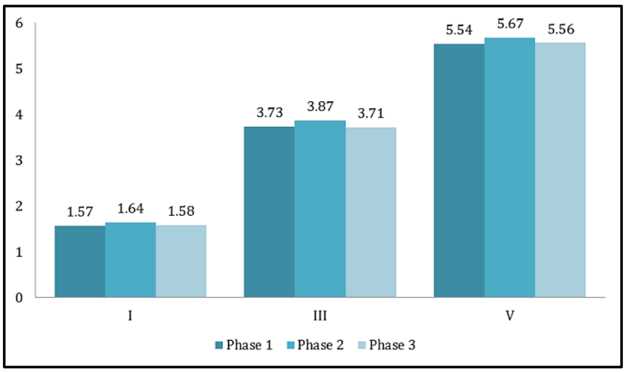

Figure-1: Showing Absolute Latencies of Different Waves of Brain Stem Auditory Evoked Potentials in Different Phases of Menstrual Cycle

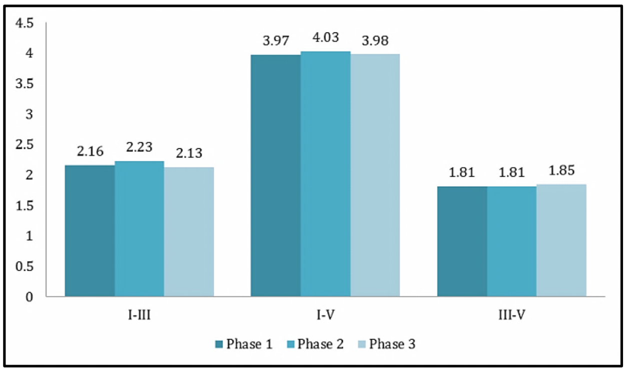

Figure-2: Showing Interpeak Latencies of Different Waves of Brain Stem Auditory Evoked Potentials in Different Phases of Menstrual Cycle

The absolute latencies of the waves, I-V [Figure 1 & 2, Table 1, 2 & 3] showed:

1. A statistically significant increase in the proliferative phase (phase 2) subjects as compared to that in the menstrual phase (phase1) subjects.
2. A highly significant to a significant decrease in the secretory (phase 3) as compared to that in the proliferative phase (phase 2)
3. No significant change was found in the interpeak latency in all the phases.

Table-1: Comparison of Absolute Latencies and Inter-Peak Latencies of Different Waves of Brain Stem Auditory Evoked Potentials between Phase 1 and Phase 2 of Menstrual Cycle

	Phase 1	Phase 2	't' value	'p' value	Significance
Latency (ms) Mean ± SD					
I	1.57 ± 0.12	1.64 ± 0 .12	2.6	0.013	S
III	3.67 ± 0.18	3.87 ± 0.16	3.16	0.003	S
V	5.54 ± 0.2	5.67 ± 0.2	2.9	0.006	S
Inter-peak Latency (ms) Mean ± SD					
I-III	2.16 ± 0.29	2.23 ± 0.22	1.21	0.234	NS
I-V	3.97 ± 0.25	4.03 ± 0.24	1.09	0.282	NS
III-V	1.87 ± 0.29	1.81 ± 0.28	0	0.999	NS

Table-2: Comparison of Absolute Latencies and Inter-Peak Latencies of Different Waves of Brain Stem Auditory Evoked Potentials between Phase 2 and Phase 3 of Menstrual Cycle

	Phase 2	Phase 3	't' value	'p' value	Significance
Latency (ms) Mean ± SD					
I	1.64 ± 0 .12	1.58 ± 0.12	2.23	0.03	S
III	3.87 ± 0.16	3.68 ± 0.26	3.22	0.003	S
V	5.67 ± 0.2	5.56 ± 0.2	2.45	0.188	S
Inter-peak Latency (ms) Mean ± SD					
I-III	2.23 ± 0.22	2.10 ± 0.29	1.73	NS	NS
I-V	4.03 ± 0.24	3.98 ± 0.25	0.91	0.368	NS
III-V	1.81 ± 0.28	1.88 ± 0.31	0.6	0.551	NS

Table-3: Comparison of Absolute Latencies and Inter-Peak Latencies of Different Waves of Brain Stem Auditory Evoked Potentials between Phase 1 and Phase 3 of Menstrual Cycle

	Phase 1	Phase 3	't' value	'p' value	Significance
Latency (ms) Mean ± SD					
I	1.57 ± 0.12	1.58 + 0.12	0.37	0.7	NS
III	3.67 ± 0.18	3.68 + 0.26	0.35	0.728	NS
V	5.54 + 0.2	5.56 + 0.2	0.44	0.66	NS
Inter-peak Latency (ms) Mean ± SD					
I-III	2.10 + 0.23	2.10 + 0.29	0.46	0.648	NS
I-V	3.97 + 0.25	3.98 + 0.25	0.17	0.992	NS
III-V	1.87 ± 0.29	1.88 ± 0.31	0.55	0.585	NS

DISCUSSION

The waves of Auditory Brainstem Response ABR (I-V) represent volume conducted electrical activity from auditory nerve to midbrain through medullo-ponto-lemniscal system.[13] In our study, absolute latencies of waves I, III and V in phase 2 was more than of phase of 1. Variation in different hormonal levels especially estrogen and progesterone across the menstrual cycle have been proposed to be responsible for the latency changes of the waves of auditory evoked potentials.[14] Our studies in rural subjects is similar to earlier reports in which significant increase in the peak latencies of the waves, I-V in the oestrogen peak mid cycle was observed, while a significant decrease in the progesterone peak mid-luteal phase was observed.[15] However, no significant differences in the brainstem auditory evoked potentials in the progesterone phase compared with the estrogen phase was observed in study conducted on young normal females.[12]

Increase in latency of waves I, III and V in phase II may be due to increase in oestrogen and decrease in latency of waves in phase III may be due to increase in progesterone. Estrogen might influence acetylcholine (Ach) synthesis which was shown to be present in the auditory system.[16] Estrogen may enhance the inhibitory effects of GABA by stimulating its secretion thereby delaying its conduction. Conversely Progesterone may decrease the sensitivity of neurons and blunt the estrogen potentiated GABA release. When administered alone, progesterone had no significant effect on GABA binding in any hormone sensitive brain region. Evidence to support this hypothesis emerges from several physiological and pharmacological studies of hormonal effects on auditory brainstem pathways.[17]

The peak latencies of all waves in phase III are lower than in phase II in the present study. Estrogen has been shown to have a dual action on GABA release in female primates. This is based on research that pulsatile release of hypothalamic GABA significantly increased in female monkeys at the time of estrogen surge and abolished during the negative feedback phase. [18] This biphasic response of GABA to estrogen action helps to explain the rise in latencies during mid-cycle in ovulating females. At mid-cycle estrogen has a positive feedback action resulting in enhanced GABA secretion in brain whereas it has a negative feedback action during early follicular and late luteal phase which cause decrease in absolute latencies.

Estrogen and progesterone exert their effects on brain by regulating neurotransmission and membrane excitability and sex steroids interact directly with the surface membrane receptors to change the excitability of nerve cells in the hypothalamus and hippocampus[19,20] Shortest latencies of all the waves were seen during phase I which imply that withdrawal of sex hormones improve hearing threshold.

Interpeak latencies of waves I-III, I-V and III-V were recorded in three phases of the menstrual cycle. The interpeak latency I-III and I-V is the measure of the conduction time from the VIIIth nerve across the subarachnoid space into the core of the lower pons) from the proximal VIIIth nerve through the pons to the midbrain respectively. Interpeak latency III-V waves measures conduction from lower pons to midbrain. In our study, on comparing inter-peak latencies of rural healthy young females in phase 2 of menstrual cycle with phase 1 and females in phase 3 with phase 2 showed no significant change in inter-peak latency .This could be due to simultaneous increase in absolute latencies of waves I,III and V in phase 2 and simultaneous decrease of absolute latencies of all waves I,III &V in phase 3 of the menstrual cycle.

CONCLUSION

This study indicates that normal cyclic variations of female sex hormones especially estrogen and progesterone modify the central processing of the auditory information. No difference was observed on the effect of sex hormones on conduction studies from earlier studies done in urban population. Further studies are required to compare urban and rural females in same area and also to investigate along with the hormonal level assessment, if the variations of wave latencies and interpeak intervals of ABR could contribute to variation in the hearing ability of the subject and if so in what way.

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