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Physiology

AUDITORY EVOKED POTENTIAL STUDY IN YOUNG HEALTHY FEMALES DURING DIFFERENT MENSTRUAL CYCLE PHASES

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ABSTRACT

Introduction: The hormonal variation during menstrual cycle has its influence all over the body including CNS. BAEP is a non-invasive method to assess auditory information, thus it provides information about sensory processing.

Aims and Objectives: To evaluate BAEP in normal healthy females during different menstrual cycle phases.

Material and methods: A cross-sectional study, conducted among 80 females of age group 18-20years having regular menstruation. BAEP was recorded in 3 phases of the menstrual cycle. The data was analysed by one way ANOVA.

Result: The BAEP waves showed statistically significant decrease in wave V and inter-peak latencies III-V and I-V in phase 2 and increase in phase 3.

Conclusion: The study showed that BAEP wave changes are due to ovarian hormones, which modified the central processing of audition.

KEYWORDS : Brainstem Auditory Evoked Potential (BAEP), menstrual cycle

I.INTRODUCTION

Menstrual cycle is the cyclical changes that occur in female after attainment of puberty. [1] It consists of menstrual phase, proliferative phase and secretory phase. The hormone secreted in the proliferative phase is oestrogen and that of secretory phase is progesterone. [2] The hormonal variations that occur during the menstrual cycle have its effect all over body including central nervous system. [3] It also influences different sensory modalities like vision, light perception, hearing, taste, and olfaction. [4]

Oestrogen receptors have been identified in the inner ear. Thus oestrogen has its influence in auditory transmission through receptors [3] Neurological illnesses such as myasthenia gravis, multiple sclerosis, meningioma, epilepsy, arterio-venous aneurysms, and migraine may be worse during the pre-menstrual phases. [5]

The effect of hormones on CNS especially in sensory system can be detected with the help of evoked potential studies. Brainstem Auditory Evoked Potentials (BAEP), an objective test which helps to assess conduction of auditory impulses through the auditory pathway up to midbrain.[5] These are very small electrical voltage potentials which are originated from brain in response to sound stimulus and can be recorded from the scalp. [6] Analysis of BEAPs consists of measuring the absolute latency, absolute amplitude of waves I to V and inter peak latency (IPL) I-V, I-III and III–V waves. [7]

AIMS AND OBJECTIVES:

To evaluate BAEP in normal healthy females during different menstrual cycle phases.

II.MATERIALS AND METHODS

After getting Institutional Ethical committee approval, a written informed consent was obtained from all the volunteers before enrolling them into the study.

This was a cross-sectional study conducted among 80 young healthy female nursing students of age group 18-20years having regular menstrual cycle with BMI between 18 to 25kg/m^2 & having no hearing abnormalities. Females with history of irregular periods, drug intake like hormonal pills, steroids, endocrine abnormality, metabolic or neoplastic pathologies, chronic illness, neurologic or psychiatric illness, auditory defects, pregnancy & lactation are excluded from the study.

After taking a detailed menstrual history, anthropometric data was taken. Preliminary selection tests on hearing were performed to exclude conduction defect. The subject was seated comfortably in an arm chair in an electrically and acoustically shielded room and was briefed about the procedure before doing the test. The test was done between 10 and 12 am. During their menstrual cycle each women was subjected to brain stem auditory evoked potential (BAEP) tests for three times, the first at the menstrual phase (day 1-4) taken as Phase 1,the second at the proliferative phase (day 5-14) taken as Phase 2, the third at the secretory phase (day 15-28) taken as Phase 3 using RMS Aleron 401 EMG/NCV/EP system.[8] The day of ovulation was found out by the basal body temperature chart.

Recording of Brainstem Auditory Evoked Potential (BAEP):[7]

By using electrode paste the recording (active) electrodes were pasted on the mastoid process of both ears, reference electrode at vertex Cz and the ground electrode in front of the vertex according to the 10–20 international system of EEG electrode placement. The site of application was cleaned with an spirit before the electrode placement. All electrodes were plugged to a junction box and skin to electrode impedance was kept below 5 Kohm. 2000 click stimuli which had an intensity of 70dB above the normal hearing threshold were given to each ear separately, at the rate of 11.1/sec and for a duration of 0.1 ms. The sweep speed was 1ms/division and the sensitivity was 0.5µV/div. These clicks were generated by passing 0.1 ms square pulses through shielded headphones. Contralateral ear was masked by white noise at 40 dB SPL. Signals picked up by electrodes were filtered, amplified, averaged and displayed on the screen of BERA machine. The peak latencies of the waves, I, II, III, IV and V, the inter peak latencies of I-V, I-III and III-V, and the amplitude ratio (V/I) were recorded. The wave forms were analysed separately for each ear. Data was entered in Microsoft excel 2007 office and was analysed using statistical software SPSS – 16.0.Version. The statistical analysis of the results was done by using one-way ANOVA test. P value <0.05 was considered as statistically significant.

RESULT:

In the present study, total 80 subjects were recruited after considering inclusion and exclusion criteria. They were tested in three different menstrual cycle phases- menstrual phase (phase 1), proliferative phase (phase 2) & secretory phase (phase 3).

Table 1 - Inter Peak Latencies (ms) of different waves of BAEP in different menstrual cycle phases.

Inter Peak latencies (ms)	Phase 1 (mean ± SD)	Phase 2 (mean ± SD)	Phase 3 (mean ± SD)
Wave latency (I – III)	1.99 ± 0.25	1.98 ± 0.23	2.01 ± 0.35
Wave latency (III – V)	2.01 ± 0.29	2.04 ± 0.35	2.19 ± 0.35*
Wave latency (I – V)	3.99 ± 0.37	3.95 ± 0.46	4.19 ± 0.36 *

[*P is significant compared Phase 2 with Phase 3 at Inter peak latencies at (III- V) (P<0.003) and (I- V) (P<0.004) and compared Phase 3 with Phase1 at Inter peak latencies at (III- V) (P<0.003) and (I- V) (P<0.005)]

Table 2 - Latencies (ms) of different waves of BAEP in different menstrual cycle phases

BAEP waves latencies (ms)	Phase 1 (mean ± SD)	Phase 2 (mean ± SD)	Phase 3 (mean ± SD)
Wave - I	1.68 ± 0.05	1.66 ± 0.12	1.69 ± 0.14
Wave - II	2.78 ± 0.12	2.78 ± 0.07	2.79 ± 0.13
Wave - III	3.65 ± 0.10	3.64 ± 0.14	3.66 ± 0.10
Wave - IV	5.00 ± 0.17	4. 99± 0.35	5.11 ± 0.38
Wave - V	5.73 ± 0.36	5.51 ± 0.32	5.92 ± 0.39 *

(*P is highly significant compared Phase 2 with Phase 3 in wave V (P<0.00) and Phase 3 with Phase 1 in wave V (P<0.002)

A statistically significant decrease in latency of BAEP wave V and inter-peak latencies III-V and I-V during phase 2 of menstrual cycle as compared to phase 3 and an increase in latency of the same wave during (phase 3 as compared to phase 1. The latencies of waves I, II, III, IV and inter -peak latency I-III showed the same trend but statistically insignificant. The latency changes and inter-peak latency changes during different phases has been depicted in the table 1 and 2 respectively

Table 3 - Amplitude ratio V/I of BAEP in different menstrual cycle phases

	Phase 1 (mean ± SD)	Phase 2 (mean ± SD)	Phase 3 (mean ± SD)
Amplitude ratio V/I	0.93 ± 0.39	1.01 ± 0.40	0.90 ± 0.44

A statistically insignificant decrease in amplitude ratio of BAEP (p >0.05) during phase 3 as compared to phase 2 and a statistically insignificant increase in the same during phase 2 as compared to phase 1. Amplitude ratio during different phases has been depicted in the table 3.

DISCUSSION

The menstrual cycle is a time of widespread changes affects both mentally and physically. [8,9]The hormonal variation during menstrual cycle produce changes in almost all systems in our body including CNS.[10,11,12] Evoked potential studies are non-invasive method to assess the processing of sensory information in the human central as well as peripheral nervous system.[13,14] Brainstem auditory evoked potentials (BAEPs) are electrical potentials generated in response of auditory nerve, brainstem and higher subcortical structures to acoustic stimulus.[15] Since the hormonal variation during menstrual cycle affect the processing of sensory information, this study is aimed to find the effect of variation in hormones on the peripheral and central conduction time of auditory stimuli.[14]

The present study showed a statistically significant decrease in latency of wave V and inter-peak latencies I-V and III-V in the oestrogen peak follicular phase and a statistically significant increase in the same parameters of BAEP in progesterone peak secretory phase. Similar results are reported by Caruso et al. and Serra et al. Oestrogens modulate sensory processing via interactions with neurotransmitters such as dopamine, gamma aminobutyric acid, glutamate, and serotonin by this way alter the speed of sensory neurotransmission at different levels of the CNS.[16]Similar results in Coleman et al.

Oestrogen receptors ERα and ERβ are expressed in the peripheral and central auditory system. Fluctuations in auditory perception and in electrophysiological measures of auditory function in menstrual cycle show the importance of oestrogen actions on auditory processing. [16,17]
In the menstrual phase, during which gonadal steroids are at a low level, all the BAEP parameters showed a normal value similar to that of males. [18]

The amplitude ratio of BAEP wave V/I showed statistically insignificant increase in follicular phase and a decrease in secretory phase. This result is similar to the BAEP study in different menstrual cycle phases, done by Navpreet Mann et al. [4]

The peak latencies and inter-peak latencies reflect the conduction time in the auditory pathway. This study showed a decrease in wave latencies and inter-peak latencies at follicular phase reflects a faster auditory neural conduction in the oestrogen peak phase and an increase in the same parameters during secretory phase reflects a slower auditory neural conduction in the progesterone peak phase. The amplitude ratio showed statistically insignificant increase in follicular phase and decrease in secretory phase. This may be due to the excitatory action of oestrogen and progesterone has the opposite effect on the CNS.

Due to the excitatory effects of oestrogen, auditory function is found to be better in females. [3] Oestrogen enhances synaptic transmission and improves neural conduction. Studies have shown oestrogen replacement treatment can decrease brainstem auditory evoked potential intervals and certain latencies of the mid latency response (MLR) in postmenopausal women. [19]

Oestrogen can decrease the number of synaptic vesicles nearby the presynaptic membrane of certain inhibitory synapses. Thus it increases neuronal excitability by decreasing the $GABA_B$ receptor-mediated auto inhibition. Progesterone potentiates GABA receptor activation by a nongenomic mechanism that may involve actions at the plasma membrane. Progesterone decrease neuronal excitability by formation of allopregnanolone, which is a positive modulator of GABA and it increases inhibitory chloride ion conductance. [20]

In our study there was a statistically significant decrease in wave V latency and inter-peak latencies III-V and I-V during follicular phase and an increase in the same parameters during secretory phase. This may be due to the high influence of ovarian hormones on higher levels of auditory pathway. Other BAEP waves and inter-peak latency I-III showed statistically insignificant decrease during follicular phase and statistically insignificant increase in the same parameters during secretory phase. This may be indirectly reflecting the much less effect of the ovarian hormones on lower levels of auditory pathway. Some studies which showed similar results like this study. The study done by Caruso et al. showed shorter latencies of BAEP waves and interpeak intervals after 3 months of oestrogen therapy when compared to baseline. The findings show a protective effect of estradiol on the female auditory system and that the addition of progesterone seems to have a negative influence on the peripheral and central auditory system. [3,21]

The oestrogen and other gonadal steroids act directly on the receptors upon the cochlea and modulate the effects of neurotransmitters present along the auditory pathways. [3, 18]This effect of oestrogen in direct modulation of neurotransmitter receptor functions, and antioxidant activities have been attributed for decrease in latency of BAEP in estrogenic phase. [3,22]

CONCLUSION

The present study says that the sensory neural conduction through the auditory nerve is faster during oestrogen peaked proliferative phase and slower during progesterone peaked secretory phase. This may be due to the neuronal excitatory action of oestrogen causing a decrease in auditory neural conduction time during proliferative phase and an increase in the same during secretory phase due to the inhibitory effect of progesterone. The effect of hormones on CNS especially in auditory system was found out by Brainstem Auditory Evoked Potentials.

REFERENCES

1. Barrett KE, Barman SM, Boitano S, Brooks HL. Ganong's Review of Medical Physiology. 23rd ed. New Delhi: Tata McGraw-Hill; 2010. p. 391-418.
2. Jones EE, DeCherneyAH. The female reproductive system. In:Boron WF, Boulpaep EL. Medical Physiology updated edition. United states of America: Elsevier Saunders ;2005. p.1141-65.
3. Al-Mana D, Ceranic B, Djahanbakhch O, Luxon LM. Hormones and the Auditory System: A Review of Physiology and Pathophysiology. Neuroscience2008 ; 153: 881–900.
4. Mann N, Sidhu RS, Babbar R. Brainstem Auditory Evoked Responses in different Phases of Menstrual Cycle. J Cardiovasc Dis Res 2012;6:1640-3.
5. Misra UK, Kalita J. Clinical Neurophysiology. 2nd ed. New Delhi: Elsevier; 2006. p. 309-27.
6. Harinder J S, Ram Sarup S, Sharanjit K. The study of age and sex related changes in the brainstem auditory evoked potential. J Clin Diagn Res 2010;4:3495-9.
7. Jain Ak. Manual of Practical Physiology for MBBS. 1st ed. New Delhi: Arya publications; 2004.p. 254-73.
8. Kaur S, Manchanda KC, Garg A, Maheshwari A. Effect of female sex hormones on central auditory conductivity in young rural females Bathinda district of Punjab . Natl J physiolpharmacol 2013;3:124-8.
9. Magos AL, Studd JWW. Effects of menstrual cycle on Medical Disorders. Br J Hosp Med1985;33:68-77.
10. Resende, Silva MD, Impemba F,Achôa NB, Schelp AO. Multimodal evoked potentials and the ovarian cycle in young ovulating women. ArqNeuropsiquiatr 2000;58:418-23.
11. Ask-Upmark E. Monthly periodicity of symptoms from the central nervous system. Neurology 1955;5:584-86.
12. McDonagh JE, Singh MM, Griffiths ID. Menstrual arthritis. Ann Rheum Dis 1993;52:65-6.
13. Phurailatpam J. Evoked potentials: Visual evoked potentials (VEPs): Clinical uses, origin, and confounding parameters. J Med Society 2014;28 :140-4.
14. Solanki JD,Joshi N, Mehta HB, Shah CJ.A study of gender, head circumference and BMI as

a variable affecting BAEP results of late teenagers. Indian J Otology 2012;18:3-6.
15. Gathe BM, Gandhe MB, Gandhe SM, .Puttewar AN, Saraf C, Singh R Brainstem Auditory Evoked Potentials (BAEP)- A Pilot Study Conducted on Young Healthy Adults from Central India. J ClinDiagnRes 2014;8:16-8.
16. Charitidi K, Meltser I, CanlonB.Estradiol Treatment and Hormonal Fluctuations During the Estrous Cycle Modulate the Expression of Estrogen Receptors in the Auditory System and the Prepulse Inhibition of Acoustic Startle Response.Endocrinology 2012;153:4412–21.
17. Brainstem response of postmenopausal women. The Int Tinnitus J 2013;18:122–8.
18. Caruso S, Maiolino L, Rugolo S, Intelisano G, Farina M, Cocuzza S etal. Auditory brainstem response in premenopausal women taking oral contraceptives. Hum Reprod 2003;18: 85-9.
19. SolankiJD,Biharilal H.Sex As A Source Of Variance Affecting Auditory Evoked Potential Mehta.Egyptian J Otolaryngol 2015; 31:111–4.
20. Guimaraes P, Frisina ST, Mapes F, Tadros SF, Frisina DR, Frisina RD. Progestin negatively affects hearing in aged women.ProcNatlAcadSci USA 2006;103:14246–9 .
21. Oliveira TSCD, Sampaio ALL, Granjeiro RC, Kehrle HM, Braga SCL, Almeida ALA etal. Effect of hormone replacement therapy on the auditory brainstem response of postmenopausal women. Int Tinnitus J 2013;18:122-8.
22. Yilmaz H, Erkin EF, Mavioglu H, Sungurtekin U. Changes in pattern reversal evoked potentials. Int Ophthalmol1998;22:27-30.