National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Auditory and visual reaction times during the menstrual cycle

Christina Sudheer[1], Shivakumar Jagadeesan[2], Kararshah F Kammar[2]

[1]Department of Physiology, Koppal Institute of Medical Sciences, Koppal, Karnataka, India, [2]Department of Physiology, Karnataka Institute of Medical Sciences, Hubli, Karnataka, India

Correspondence to: Christina Sudheer, E-mail: christina.sudheer@gmail.com

Received: September 08, 2016; **Accepted:** November 13, 2016

ABSTRACT

Background: Menstrual cycle is due to cyclic variations in the levels of various sex hormones. The effects of these hormones are not limited to the reproductive system alone but affect other systems including the nervous system. **Aims and Objective:** To study the reaction times (visual reaction times [VRT]/auditory reaction times [ART]) during the three phases of the menstrual cycle, i.e., menstrual (M), proliferative (P), and secretory (S). **Materials and Methods:** This cross-sectional study was conducted on 50 healthy young unmarried females in the age group of 20-25 years, having regular menstrual cycles. VRT/ART was measured during the menstrual, proliferative, and secretory phases. The results of the reaction times were subjected to statistical analysis using Student's paired t-test for comparison of means. $P < 0.05$ was considered as significant. **Results:** The average reaction times (in milliseconds) during the different phases of the menstrual cycle were as follows: ART = M - 187.23 ± 19.20, *P* - 182.58 ± 14.63, S - 178.23 ± 13.14 and VRT = M - 190.37 ± 8.83, *P* - 185.79 ± 10.70, S - 181.53 ± 15.11. **Conclusion:** Both the ART and VRT's were longer during the menstrual phase, whereas they were shorter during the secretory phase of the menstrual cycle. The prolonged reaction times during the menstrual phase is attributable to the slowing of conduction times, due to fluid and electrolyte increase. The quicker reaction times during the secretory phase is probably due to progesterone negating the ability of estrogen to cause conduction delay.

KEY WORDS: Reaction Time; Menstrual; Proliferative; Secretory; Sex Hormones

INTRODUCTION

The normal reproductive years of a female are characterized by regular rhythmical changes in the rates of secretion of the female hormones, and the resultant changes in the ovaries and other sexual organs. This rhythmical pattern is called the female monthly sexual cycle or menstrual cycle.[1] This is governed by a well-coordinated and appropriately regulated changes in the levels of ovarian steroid hormones (estrogen and progesterone), which are responsible for producing the discrete responses in multiple tissues and organs.[2]

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2017.7.0926813112016	

The human brain has been suggested as the site at which these hormones produce their effects. These effects may involve both direct as well as indirect influences on the neurons, glia, and the blood vessels.[3] The general state of arousal of the nervous system might also vary with the different phases of the menstrual cycle.[4] The balance between the stimulatory/inhibitory modalities of the existing neural networks may be altered due to variations in the synthesis and catabolism of various CNS neurotransmitters, due to the effects of sex steroids on the corresponding enzymes.[3]

Sex hormones are known to affect a whole gamut of CNS modalities such as neurite outgrowth, synaptogenesis, dendritic branching, myelination which ultimately affects the neural plasticity.[5]

Response time has been defined as the time interval between the application of the stimulus and the response by the subject.[6] Reaction time comprises premotor and motor time. The premotor time (i.e., time from stimulus presentation to motor act initiation) contributes the maximal (84%), which assesses the central processing capability of the brain.[7]

On one hand, a significant reduction in the response time indicates an improved sensorimotor performance and/or enhanced processing ability of the CNS,[8] whereas a prolonged response time indicates a deterioration of processing capability of the CNS or poor sensorimotor performance or a combination of both.[9]

Hence, it can be postulated that the sensory motor performances could be modulated/altered during the different phases of menstrual cycle. Therefore, we envisaged this study to find out how and to what extent the sensory motor performances are being affected during different phases of menstrual cycle, by measuring the reaction time to visual (VRT)/auditory (ART) stimuli as a surrogate.

MATERIALS AND METHODS

The subjects for this study were selected from normal healthy unmarried females in the age group of 20-25 years, having regular menstrual cycles. The study was duly approved by the institutional ethical clearance committee. 50 subjects who satisfied the inclusion and exclusion criteria were selected, and informed consent was obtained from them.

The subjects, who were included in the study, were healthy unmarried females in the specified age group of 20-25 years, having regular menstrual cycles of 27-30 days for at least the last 6 months, and whose body mass index was within the normal range (18.5-24.9 kg/m^2). The exclusion criteria applied were as follows: Those taking any medication or hormonal preparations (that could alter the menstrual hormonal milieu), those having any physical illness or endocrinological disorders, smokers, alcoholics, athletes/those involved in excessive physical activity.

The subjects were instructed to visit the department during each phase of the menstrual cycle. 1-5th day, 9-12th day, and 19-22nd day were selected to represent menstrual, proliferative, and secretory phases, respectively. Daily basal body temperature recordings formed the basis for this judgment. A thorough history with special attention to menstrual history was taken. Height and weight were recorded using standard methodologies. Response times measurements (VRT and ART) were carried out during these three-phase of menstrual cycle after the subjects were thoroughly acquainted with working of "response analyzer" (YSRT – 0101 – Pune). It was ensured that no subject consumed any caffeinated products 6 h before the testing. Subjects were instructed to press a response micro switch (thumb switch) as quickly as possible, after the presentation of appropriate stimuli (light/sound), but not prematurely, with thumb of the dominant hand. The intensity of stimuli was kept constant for all the subjects. The time displayed in milliseconds was noted and taken down as the response time for that stimulus. 10 readings were taken for each one of the stimuli. The lowest readings were taken as individual values for a particular stimulus. The procedure room was a quiet and secluded room, whose ambient temperature was about 27°C. All tests were done between 10.00 am and 1.00 pm.

The results of ART and VRT during the different phases of menstrual cycle were expressed as mean±standard deviation and analyzed using student's paired *t*-test for comparison of means. $P < 0.05$ was considered as significant.

RESULTS

The average values (in milliseconds) of the ART and VRT in different phases of the menstrual cycle are provided in Table 1. Whereas the results of the statistical analysis using paired samples *t*-test for ART and VRT between various phases of the menstrual cycle are represented in Table 2. Overall, ART and VRT were shorter during the secretory phase and longer during the menstrual phase of the cycle.

DISCUSSION

The menstrual cycle involves tumultuous and rapid variations in various sex hormones and it is but natural to presume that the effects of theses hormones are not limited to

Table 1: ART and VRT during different phases of menstrual cycle (in milliseconds)

Phase	(Mean±SD)	
	ART	VRT
Menstrual	187.23±19.20	190.37±8.83
Proliferative	182.58±14.63	185.79±10.70
Secretory	178.23±13.14	181.53±15.11

ART: Auditory reaction time, VRT: Visual reaction time, SD: Standard deviation

Table 2: Paired samples t test for ART and VRT

Phase pairs	ART		VRT	
	t	*P*	*T*	*P*
I and II	4.6622	<0.001*	4.7816	<0.001*
II and III	4.6660	<0.001*	4.5675	<0.001*
I and III	5.1612	<0.001*	5.0911	<0.001*

Phase-I: Menstrual phase, Phase-II: Proliferative phase, Phase-III: Secretory phase, *Very highly significant, ART: Auditory reaction time, VRT: Visual reaction time the reproductive system, but in fact could have far-reaching effects on other bodily systems.

The sex hormones, especially estrogen and progesterone secreted from the ovaries, vary in their level during different phases of menstrual cycle. The menstrual phase is characterized by low levels of both these hormones and as we progress through the follicular phase, estrogen level rises rapidly to reach the peak just before ovulation, with progesterone levels continuing to remain low. Whereas during the luteal phase, the levels of both estrogen and progesterone rises, thus in the mid luteal phase, both the hormones are high. Hence during the normal menstrual cycle, there are two peaks of estrogen secretion, an "ovulation peak," which occurs near the end of the follicular phase and a "luteal peak." Progesterone reaches a peak about 4-7 days before menstruation.[4]

A study by Smith et al. showed for the first time that the activities of a specific neural network composed of excitatory afferents and inhibitory interneurons, that ultimately determines the excitability of corticospinal neurons, is not constant through the various phases of a normal menstrual cycle.[10]

While some studies have observed lower threshold for auditory stimuli during the beginning of the menstrual period,[11] in our study, the ART and VRT were longer in the menstrual phase and shorter in secretory phase as compared to the proliferative phase. The paramenstrual period is said to be characterized by a state of cognitive debilitation.[12]

There is also a significant increase in the incidence of accidents during the pre-menstrual (i.e., 4 days before menstruation) and menstrual periods, which is attributed to the increased lethargy leading to impaired judgment and slow reaction time. Further, it has been seen that in some air accidents involving women pilots, in which the cause of the accident could not be found, the pilots were found to be in the menstrual phase of the cycle.[13]

In a study conducted by Nene and Pazare, ART was significantly increased in premenstrual phase and on the expected day of ovulation.[14] Similarly in a study conducted by Das et al., there was a significant increase in weight as well as prolongation in auditory and visual Response times during the premenstrual phase. These changes have been attributed to fluid and salt retention occurring in this phase, which in turn leads to a decrease in the processing capability of central nervous system.[15] Bhatia et al. observed a higher threshold for evoking the V wave of BAEP and a higher absolute peak latencies of waves with a decrease in amplitude of wave V during premenstrual phase and have attributed this to the delayed conduction time of auditory impulses from auditory nerve to midbrain.[16]

Bruce and Russel, have suggested that retention of water and sodium due to variations in the levels of sex steroids during the menstrual cycle, might influence either the process of axonal conduction time or the availability of neurotransmitters at synapses in the auditory pathways.[17]

A study by Afshan et al. has found that the shortest VRT occur during the luteal phase.[18] The most likely cause for this is that estrogen causes delay in conduction by influencing gamma amino butyric acid release at the various polysensory association areas of brain, which is blunted by the presence of progesterone.[19]

The strength of this study lies in the usage of reaction times as a surrogate for measuring sensorimotor performance, as they are objective measurements and easily reproducible. The limitations of the present study are that the subjects in this study belonged to a restricted age group (20-25 years) and the classification of different phases of the menstrual cycle (i.e., menstrual, proliferative, and secretory) were based on basal body temperature measurements and not on the measurement of relevant sex hormones.

CONCLUSION

While studying the ART and VRT to appropriate sensory stimuli in healthy women, with normal menstrual cycles, we observed significantly shorter reaction times during the secretory phase, which is probably attributable to the higher levels of progesterone seen in this phase. The menstrual phase is characterized by longer reaction times, which could be due to a generalized slowing of neural conduction times, because of fluid and salt retention.

REFERENCES

1. Hall JE. Guyton and Hall Textbook of Medical Physiology. 13th ed. Philadelphia, PA: Elsevier Health Sciences; 2015. p. 1037-53.
2. Farage MA, Neill S, MacLean AB. Physiological changes associated with the menstrual cycle: A review. Obstet Gynecol Surv. 2009;64(1):58-72.
3. Fraser IS. Estrogens and Progestogens in Clinical Practice. 1st ed. Philadelphia, PA: Churchill Livingstone; 1998. p. 1-909.
4. Kopell BS, Lunde DT, Clayton RB, Moos RH. Variations in some measures of arousal during the menstrual cycle. J Nerv Ment Dis. 1969;148(2):180-7.
5. Barth C, Villringer A, Sacher J. Sex hormones affect neurotransmitters and shape the adult female brain during hormonal transition periods. Front Neurosci. 2015;9:37.
6. Mohan M, Thombre DP, Das AK, Subramanian N, Chandrasekar S. Reaction time in clinical diabetes mellitus. Indian J Physiol Pharmacol. 1984;28(4):311-4.
7. Christopher G. The Psychology of Ageing: From Mind

to Society. 1st ed. Hampshire: Palgrave Macmillan; 2013. p. 44-57.
8. Madanmohan, Thombre DP, Balakumar B, Nambinarayanan TK, Thakur S, Krishnamurthy N, et al. Effect of yoga training on reaction time, respiratory endurance and muscle strength. Indian J Physiol Pharmacol. 1992;36(4):229-33.
9. Kapoor R, Singh SH, Gandhi A. Autonomic functions and audiovisual reaction time in heroin addicts. Indian J Physiol Pharmacol. 1993;37(3):209-12.
10. Smith MJ, Keel JC, Greenberg BD, Adams LF, Schmidt PJ, Rubinow DA, et al. Menstrual cycle effects on cortical excitability. Neurology. 1999;53(9):2069-72.
11. Baker MA, Weiler EM. Sex of listener and hormonal correlates of auditory thresholds. Br J Audiol. 1977;11(3):65-8.
12. Richardson JT, editor. The menstrual cycle, cognition, and paramenstrual symptomatology. Cognition and the Menstrual Cycle. 1st ed. New York: Springer-Verlag; 1992. p. 1-38.
13. Dalton K. Menstruation and accidents. Br Med J. 1960;516:326-38.
14. Nene AS, Pazare PA. A study of auditory reaction time in different phases of the normal menstrual cycle. Indian J Physiol Pharmacol. 2010;54(4):386-90.
15. Das S, Gandhi A, Mondal S. Effect of premenstrual stress on audiovisual reaction time and audiogram. Indian J Physiol Pharmacol. 1997;41(1):67-70.
16. Bhatia S, Tandon OP, Sharma KN. Brainstem auditory and visual evoked potentials in menstrual cycle. Ann Natl Acad Med Sci. 1991;2:177-82.
17. Bruce J, Russell GF. Premenstrual tension. A study of weight changes and balances of water, sodium, and postassium. Lancet. 1962;2(7250):267-71.
18. Afshan A, Bahulekar A, Swati IA. The influence of different phases of normal menstrual cycle on simple visual reaction time. Int J Bioassays. 2013;2(4):716-8.
19. Yadav A, Tandon OP, Vaney N. Long latency auditory evoked responses in ovulatory and anovulatory menstrual cycle. Indian J Physiol Pharmacol. 2003;47(2):179-84.

How to cite this article: Sudheer C, Jagadeesan S, Kammar KF. Auditory and visual reaction times during the menstrual cycle. Natl J Physiol Pharm Pharmacol 2017;7(3):297-300.

Source of Support: Nil, **Conflict of Interest:** None declared.