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RESEARCH ARTICLE

Study on variation of simple reaction time during menstrual cycle among undergraduate medical students

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ABSTRACT

Background: Females have a monthly cyclical change in the levels of estrogen and progesterone during the pre-menstrual and post-menstrual phase. These hormones affect the sensory-motor association. Measurement of reaction time in the pre- and the post-menstrual phase gives us an understanding of the effect of fluctuating levels of these hormones on the processing capabilities of the brain. **Aims and Objectives:** The present study was aimed at assessing the influence of estrogen and progesterone on auditory reaction time (ART) and visual reaction time (VRT). **Materials and Methods:** Fifty female undergraduate medical students having age between 18 and 21 years with eumenorrheic cycles were recruited in the study. ART and VRT were assessed in the pre- and the post-menstrual phase using digital reaction time apparatus for simple choice discriminative R.T with built-in timer and chronoscope with a display accuracy of 1 ms. The paired "*t*-test" was used for analyzing the results statistically. **Results:** The current study showed a non-significant increase in ART ($P = 0.611$) and VRT ($P = 0.512$) values in the pre-menstrual phase. **Conclusion:** There was no statistically significant influence of estrogen and progesterone on the reaction time. Even though the reaction time in pre-menstrual phase is higher than post-menstrual phase, the non-significant difference of reaction time between pre- and post-menstrual phase may be attributed to a similar lifestyle in all the study participants.

KEY WORDS: Ovarian Hormones; Post-menstrual Phase; Pre-menstrual Phase; Simple Reaction Time; Undergraduate Medical Students

INTRODUCTION

The women's reproductive system undergoes periodic anatomical and physiological changes to get prepared for the process of fertilization and implantation. This cycle in humans is considered as a menstrual cycle which is characterized by periodic shedding of endometrium and bleeding per vaginum.[1] Menstrual cycle has three phases – menstrual phase, proliferative phase (under the influence of estrogen), and secretory phase (under the influence of estrogen and progesterone). Ovarian steroids have a considerable amount of effect on cognition and affective state of brain by influencing different regions of brain-like hippocampal formation, basal forebrain cholinergic system, catecholaminergic neurons, and serotonin pathways.[2] According to clinical observations, cyclical changes in the levels of progesterone and estrogen in the pre-menstrual phase and post-menstrual phase are affecting the latency of auditory evoked potential waves and thresholds for auditory, olfactory, and taste stimuli.[3]

The processing abilities of nervous system can be indirectly assessed by measuring reaction time. It defines the time

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interval between the application of a stimulus and appropriate voluntary response from the subject.[4] Human reaction time involves detection of stimulus by the receptors and projecting the information to brain through afferent pathways. The brain processes the signal and sends the necessary response information to effectors through efferent pathways. Evidences from previous studies showed mean simple reaction time (SRT) as 190 ms for light stimuli and about 160 ms for sound stimuli among college students.[5] Reaction time is of three types. SRT is giving a particular reaction to a single stimulus. In recognition reaction time (RRT), the subject has to select the appropriate response to different types of stimuli, and the response varies with the type of the stimuli. Cognitive reaction time (CRT) consists of identifying the significance of the stimuli, the association, and application of knowledge to develop an optimal cognitive response in agreement with the stimulus complexity.[5]

Hence, the present study is aimed at assessing the influence of fluctuating levels of estrogen and progesterone on cognitive effects indirectly, by measuring auditory reaction time (ART) and visual reaction time (VRT) during the pre-menstrual and post-menstrual phase of the menstrual cycle.

MATERIALS AND METHODS

This descriptive observational study has been conducted among a purposive sampling of 50 normal menstruating medical students of age group 18–21 years in the Department of Physiology in a Private Medical College of Coastal Andhra Pradesh. Institutional Ethical committee clearance and written informed consent from all the study participants was taken before the commencement of the study.

Subjects with regular menstrual cycles for at least past 6 months in the age group of 18–21 years, having normal auditory abilities (tested with tuning fork tests- Rinne's and Weber's test), having normal visual abilities (tested with Snellen's, Jaeger's, and Ishihara's charts) were included in our study. Subjects having irregular menstrual cycles, audiovisual disturbances, with history of any psychiatric illness, sleep disorders for the past 6 months, alcohol and smoking habits, drug addiction, taking medication (such as sedatives, antiepileptics, hypnotics, tranquilizers, steroid, and contraceptives), under gynecological treatment, pregnant, and lactating women were excluded from our study.

ART and VRT were recorded in all subjects in pre-menstrual phase (considered as 1–7 days before the commencement of next menstruation) and post-menstrual phase (taken as 5^{th}–10^{th} day of menstrual cycle) between 9 am and 11 am in a quiet environment temperature between 22°C and 25°C.[6] The participants were advised to come at least 2 h after breakfast with empty bowel and bladder.

Digital reaction time apparatus for simple choice discriminative R.T with built-in timer and chronoscope with display accuracy of 1 ms (By Psychotronics, Bangalore model number 501-004TR) was used for the present study. Auditory click sound stimulus was used to assess ART while green light was used for VRT. Each subject was assessed separately and instructed to release the response key as soon as they perceived respective stimuli. The subjects were asked to use their dominant hand while responding to the click sound or green light signals that were given only from their front to avoid any confounding effect of the lateralized stimulus. On 2 days before the actual testing, all subjects were familiarized with the procedure and equipment as reaction time is found to be more consistent in subjects who have adequate practice. Ten trials were recorded for both auditory and visual signals, and the average of the lowest three similar observations was taken as a single value as per established norms.[7] Statistical analysis was done using paired "*t*-test" using Microsoft Excel. $P < 0.05$ with a confidence interval of 95% was considered as statistically significant.

RESULTS

From Table 1, the mean age of the study participants is 19.08 ± 0.89 years. Average age of attaining menarche is 12.64 ± 1.14 years. Average duration of menstrual cycle in the study participants is 28.92 ± 1.89 days and the average duration of menstrual phase is 4.67 ± 0.7 days.

From Table 2, the mean ± S.D of VRT during pre-menstrual phase and post-menstrual phase is 223.88 ± 37.61 and 218.48 ± 50.98, respectively. Calculated *t*-value and *P* value of VRT are −0.66 and 0.512. From Table 2, the mean ± S.D of ART during pre-menstrual phase and post-menstrual phase is 207.85 ± 44.53 and 203.69 ± 53.79, respectively. Calculated *t*-value and *P* value of ART are −0.512 and 0.611.

DISCUSSION

In our study, the mean ± S.D of VRT during pre-menstrual phase and post-menstrual phase is 223.88 ± 37.61 and 218.48 ± 50.98, respectively. The mean ± S.D of ART during pre-menstrual phase and post-menstrual phase is 207.85 ± 44.53 and 203.69 ± 53.79, respectively. Even though ART and VRT values were more in the pre-menstrual

Table 1: Mean±SD of age, age of menarche, the average duration of the menstrual cycle, and average duration of menstrual phase

Parameter	Mean±SD
Age (in years)	19.08±0.89
Age of menarche (in years)	12.64±1.14
Duration of the menstrual cycle (in days)	28.92±1.89
Duration of menstrual phase (in days)	4.67±0.7

Table 2: Comparison of VRT and ART (in ms) between pre- and post-menstrual phase

Reaction time	Premenstrual phase Mean±SD	Post-menstrual phase Mean±SD	*t*-value	*P*-value	Remarks
VRT	223.88±37.61	218.48±50.98	−0.66	0.512	*P*>0.05 (Not significant)
ART	207.85±44.53	203.69±53.79	−0.512	0.611	*P*>0.05 (Not significant)

ART: Auditory reaction time, VRT: Visual reaction time

phase, there was no statistically significant difference between pre-menstrual and post-menstrual phases as *P* value of VRT is 0.512 and for ART is 0.611 ($P < 0.05$ was considered statistically significant).

Studies done by Jadhav[8] showed a highly significant ($P < 0.001$) increase of VRT in the pre-menstrual phase (241.83 ± 38.71) when compared to post-menstrual phase (212.87 ± 29.02). Sudheer *et al*.[9] showed a highly significant ($P < 0.001$) increase of both ART and VRT in the pre-menstrual phase. Patel *et al*.[10] showed a significant ($P < 0.005$) increase of both simple VRT and choice VRT in the pre-menstrual phase. It has been postulated that during the pre-menstrual phase, there is evidence of progesterone withdrawal, raise in secretion of aldosterone and vasopressin, leading to accumulation of water and sodium.[11] Water and sodium accumulation may delay axonal conduction and the amount of neurotransmitter available at synapses in the auditory pathway which ultimately leads to delayed conduction and thus elevates ART in the pre-menstrual phase.[12] Estrogen augments glutamate receptor activity through reduction of gamma-aminobutyric acid (GABA) production. Progesterone enhances GABA neurotransmission and inhibits neural excitement. These fluctuating levels of estrogen and progesterone during pre-menstrual and post-menstrual phases are responsible for longer reaction times in the pre-menstrual phase.[13] Corneal thickness varies during the menstrual cycle. It is thinnest at the beginning of the cycle and thickest at the end. It might be responsible for decreased vision and prolongation of VRT in the pre-menstrual phase.[14] Studies done by Veena *et al*.[1] showed non-significant difference of ART ($P = 0.14$) and VRT ($P = 0.09$) between mid-secretary phase and proliferative phase. Bhutkar and Aparna[15] showed a non-significant difference in ART ($P = 0.305$) and VRT ($P = 0.464$) value among pre-menstrual phase, post-menstrual, and menstrual phase of menstrual cycle similar to the current study. The reasons for the non-significant increase of ART and VRT values in the pre-menstrual phase in the current study may be, only students in the age group of 18–21 years are recruited. Further, all of our study participants are young undergraduate medical students who have similar lifestyles.

The strength of the study is when compared to other similar studies, inclusion and exclusion criteria are more substantial in the current study. Rinne's test and Weber's tests are used to rule out participants with auditory disturbances rather than with mere history taking. And to rule out visual disturbances, far vision is tested with Snellen's chart, near vision with Jaeger's chart, and color vision with Ishihara charts. The limitations of the study are it is a cross-sectional study, sample size is less (50), recruitment of study participants is by convenience sampling technique. And further, study participants within a narrow age group of 18–21 years only are recruited.

CONCLUSION

The current study reveals that there is no influence of fluctuating levels of ovarian hormones on ART and VRT between pre-menstrual and post-menstrual phases of menstrual cycle. The implications of the study can further be improved using CRT instead of SRT and people with different lifestyles should be included in the study. The effectiveness of the study is increased further by including hormonal assay for finding the phase of menstrual cycle instead of mere history from the participants.

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