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Effect of Various Phases of Menstrual Cycle on Simple Reaction Time

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Abstract: ***Background: Menstrual cycle is a physiological process and is associated with alteration of the levels of sex steroids. Gonadal steroids have reproductive functions but display neuroactive effects also. Reaction time can be taken into consideration in neurological and behavioural assessment of women during various phases of menstrual cycle. Aims and Objectives: This study was undertaken to observe the effect of gonadal hormones during various phases of menstrual cycle on simple reaction time. Methods: The study was carried out in 100 eumenorrheic females belonging to the age group of 17-19 years. Their visual and auditory reaction time were measured during menstrual (day 1-5), Proliferative (day 6-14) and Secretory (day 15-28to 30) phases by using an instrument called 'Audio-Visual Reaction time apparatus' (Medicaid systems, Chandigarh). Results were expressed as Mean±S.D. and compared with Student's paired t test. Results: The significant increase (prolongation) in visual and auditory reaction time was observed during secretory phase. Conclusion: The fluctuating levels of ovarian hormones during the various phases of menstrual cycle influence the visual and auditory reaction time and thereby affect sensorimotor association and processing capability of central nervous system.***

Keywords: Visual Reaction Time, Auditory Reaction Time, Menstrual Cycle

1. Introduction

Menstruation is a physiological process in which there is cyclical bleeding per vaginum in females during reproductive age. This is due to cyclical production of estrogens and progesterone by ovaries with associated changes in endometrium of uterus (1).

During menstruation, levels of estradiol and progesterone are low while the follicular phase is characterized by high estradiol levels and the luteal phase by high concentrations of both the hormones (2). Gonadal steroids have reproductive functions but display neuroactive effects also. There is also evidence that basic sensory skills vary during the menstrual cycle (3).

Reaction time is the time interval between the application of a stimulus and the appearance of appropriate voluntary response by a subject. It acts as a reliable indicator of rate of processing of sensory stimuli by central nervous system and its execution in the form of motor response (4). Reaction time can be taken into consideration in neurological and behavioural assessment of women during various phases of menstrual cycle.

In this study, simple reaction time was measured in the three phases of menstrual cycle i.e. during menses (levels of estradiol and progesterone are low), proliferative phase (high estradiol levels) and during secretary phase (concentrations of both hormones are high) (5).

The present study was aimed to elucidate the effects of various phases of menstrual cycle on simple reaction time.

2. Material and Methods

The study was carried out in the Department of Physiology, Govt. Medical College, and Hospital, Chandrapur. The present study included 100 healthy eumenorrhoeic females of age 17-19 yrs. They were mainly medical students of this institution.

All healthy females having regular menstrual cycle (28-30days) were selected. Subjects included in the study were right handed, non-alcoholic, non-smokers having normal vision and hearing. They were not having any pathology or injury to the upper limb. Females with history of psychiatric illness or recent psychological trauma or sleep disorders, history of color blindness, use of contraceptive pills were excluded from the study. They were instructed to chart their basal body temperature (BBT) by using digital basal thermometer provided to them, for 2 months prior to the study to document the ovulatory menstrual cycles. Those having irregular / an ovulatory (using BBT Chart) menstrual cycles were excluded from the study. A detailed menstrual history was noted. A general physical examination including the height (cm) and weight (kg) of the subjects was recorded.

Their Visual Reaction Time (VRT) and Auditory Reaction Time (ART) (seconds) were measured during the Menstrual (day 1-5), Proliferative (day 6-14), and Secretary (day 15-28) phases of menstrual cycle.

Measurement of reaction time

The present study was conducted on 'Audio-Visual Reaction time apparatus' (Medicaid systems, Chandigarh). The instrument has a display accuracy of ± 0.001 sec. the simple reaction time was measured in a quiet, closed and well illuminated room. Two modes of providing stimulus-audio stimulus (high and low frequency continuous sound on speaker) and visual stimulus (shooting red and green lights) are used for recording the auditory and visual reaction time. As soon as the stimulus was perceived by the subject, she responded by pressing the response switch by the index finger of the right hand. The display indicated the reaction time in seconds. They were given adequate trials and after repeated practice, three readings for each

parameter were noted. The average of three readings was taken as the value for simple reaction time (6) and was noted in the subject's record profile.

The protocol of the study was approved by the Institutional Ethics Committee and the volunteers gave their informed consent for participation in the study.

Statistical Analysis

All parameters were expressed as Mean ± S.D and were statistically compared with Student's paired t test. The statistical analysis was done by using SPSS software. Statistical significance for all tests was set at $p<0.05$.

3. Results

Table I shows basic Anthropometric measurements of subjects.

Table II and III shows the visual and auditory reaction time in three phases respectively. The VRT and ART show statistically significant difference between phases I & III (menstrual & secretary) as well as in phases II & III (proliferative & secretory). There is no significant difference between phases I & II (menstrual & proliferative). That is VRT (mean, for green and red lights) and ART (mean, for low and high pitches) are more in secretory phase as compared to menstrual and proliferative phases.

4. Discussion

Monthly oscillations in ovarian steroids induce uterine endometrium to enter different stages. Thus ovarian steroids (estrogen and progesterone) undergo cyclic changes in a normal menstrual cycle. During proliferative phase, progesterone production is low and estrogen levels increase gradually and during secretary phase, both estrogen and progesterone are increased with prominent increase in progesterone.

Besides affecting the hypothalamus and other brain areas related to reproduction, ovarian steroids have widespread effects throughout the brain, on serotonin pathways, catecholaminergic neurons, and the basal forebrain cholinergic system as well as the hippocampal formation, a brain region involved in spatial and declarative memory.[7]

Reaction time measurement includes the latency in sensory neural code traversing peripheral and central pathways, perceptive and cognitive processing, a motor signal traversing both central and peripheral neuronal structures and finally the latency in the end effector activation.[8]

The results of the study show prolongation of both visual reaction time (VRT) & auditory reaction time (ART) during secretary phase as compared to menstrual and proliferative phase.

This finding is consistent with the study of **Pawar Babyminakshi L et al.** [2006][9] which also shows the prolongation of both ART and VRT during premenstrual phase as compared to those during postmenstrual phase. **Das S et al**. [1997][4] also observed significant increase in weight and reaction time during premenstrual phase. **Bruce and Russel [1962][10]** explained it on the basis of varying level of sex steroids during different phases of menstrual cycle which have sodium and water retaining effect. This retention of salt and water could modify the axonal conduction. It is also suggested to alter the availability of the neurotransmitter at the synaptic level. This modulation of neurotransmitter coupled with altered rate of impulse transmission due to fluctuation in the levels of hormones affect the sensory motor association with the processing speed at the Central Nervous System.

Animal study by Bitran demonstrated that progesterone induced anxiolytic response was highly correlated with an increased levels of its metabolite pregnenolone in blood and brain. It was associated with facilitations of GABA stimulated Cl- influx in cortical synaptic neurons.[11]. Estrogen may enhance the inhibitory effect of GABA by stimulating its secretion there by delays the conduction of impulses. Progesterone may decrease the sensitivity of neurons [12]. Bovine adrenochromaffin cell study by Callachan et al stated that progesterone metabolite potentiate action of GABA and directly activate GABA-A receptors[13]. It is reported that there is estrogen induced up regulation of GABA receptors in nervous tissues of rodents.[14].
Increased chloride entry into brain cells serves to hyperpolarize the membrane and thereby inhibits neural transmission. This neural transmission inhibition affects sensorimotor association and processing capability of central nervous system.[15]

Our observations are consistent with the observations of the other workers [16, 4, 9]. In the present study, it has been observed that females had a longer reaction time in secretary phase. **Venkatesh et al [2002]**[17] observed that females had a longer reaction time when compared to males. **Loucks and Thompson** [1968][18] measuring simple reaction time on days 1, 3, 6, and 20 also failed to find a cyclic effect. Their selection of days omitted testing in the premenstrual phase. **Kopell et al.** [1969] (19) reported a lack of significant changes in either reaction time or skin potential

Table I: Anthropometric measurements of the subjects (n=100)

Parameters	Mean ± S.D.
Age (yrs)	17.78 ± 0.66
Height (cm)	158 ± 11.0
Weight (kgs)	48.98 ± 6.20
B.M.I. (kg/m2)	19.77 ± 2.52

Table II: Visual reaction time (VRT) during different phases of menstrual cycle

	Green light (Mean ±S.D.)	Red light (Mean ±S.D.)	Combined VRT (Mean±S.D.)
Menstrual (I)	0.28 ± 0.02	0.25 ± 0.02	0.26 ± 0.03
Proliferative (II)	0.27 ± 0.03	0.25 ± 0.03	0.26 ± 0.03
Secretary (III)	0.31 ± 0.03	0.28 ± 0.03	0.29 ± 0.03
	VRT for Green light	VRT for Red light	Combined VRT
I vs. II	p=0.195 **NS**	p=0.46 **NS**	p=0.5 **NS**
II vs.III	p=0.001 **HS**	p=0.0001 **HS**	p=0.0001 **HS**
I vs. III	p=0.0001 **HS**	p=0.0001 **HS**	p=0.0001 **HS**

NS=Not Significant, HS=Highly Significant.
p> 0.05-Significant, p<0.01 or p<0.001-Highly Significant.

Table III: Auditory reaction time (ART) during different phases of menstrual cycle

	Low Pitch (Mean ±S.D.)	High pitch (Mean ±S.D.)	Combined ART (Mean ±S.D.)
Menstrual (I)	0.259 ± 0.027	0.241 ± 0.028	0.25 ± 0.02
Proliferative (II)	0.268 ± 0.030	0.249 ± 0.02	0.21 ± 0.03
Secretary (III)	0.279 ± 0.034	0.260 ± 0.03	0.27 ± 0.03
	ART for Low pitch	ART for High pitch	Combined ART
I vs. II	p=0.269 **NS**	p=0.02 **NS**	p=0.0276 **NS**
II vs.III	p=0.001 **HS**	p=0.002 **HS**	p=0.01 **HS**
I vs. III	p=0.0001 **HS**	p=0.0001 **HS**	p=0.001 **HS**

NS=Not Significant, HS=Highly Significant.
p> 0.05-Significant, p<0.01 or p<0.001-Highly Significant

5. Conclusion

Our finding that reaction time is significantly prolonged during the secretory phase could be attributed to fluid and salt retention due to ovarian steroids or to modulation in neurotransmitter involved due to hormonal fluctuations during the various phases of menstrual cycle and thereby affecting sensorimotor association and processing capability of central nervous system.

However, the cause of these variations is still unclear and it seems reasonable to hypothesize that the effects are due to physiological variation in which estrogen and progesterone play a role. However, further studies involving hormonal assays along with reaction time measurement during menstrual cycle need to be undertaken.

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