Research Article

International Journal of Bioassays
ISSN: 2278-778X
www.ijbio.com

THE INFLUENCE OF DIFFERENT PHASES OF NORMAL MENSTRUAL CYCLE ON SIMPLE VISUAL REACTION TIME

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Received for publication: December 19, 2012; **Revised**: January 12, 2013; **Accepted**: February 21, 2013

Abstract: The measure of reaction time has been used to evaluate the processing speed of CNS and the coordination between sensory and motor system. Estrogen and progesterone can alter neuronal functioning. This study was taken up to determine any alterations in simple reaction time during different phases of normal menstruation. In our study we included 100 female first year medical and dental students with normal menstruation history. The subject's visual reaction time was measured in all the phases of menstruation. The results were expressed as mean and standard deviation. Student's paired't' test was used for statistical analysis. Each phase was compared with corresponding adjacent phases and the simple visual reaction time was found to be significantly increased ($P<0.05$) in all phases of menstrual cycle except on the days of menstruation. Hence the altered levels of hormones during menstrual cycle affect the coordination between sensory and motor system.

Keywords: Hormones, Menstrual Cycle, Premenstrual Phase, Simple Reaction Time

INTRODUCTION

The simple reaction time is the time interval between the application of a stimulus and the appearance of appropriate voluntary response by a subject (1). It involves stimulus processing, decision making and response programming. Reaction time is found to be altered by a number of factors both physiological and pharmacological (2). The processing and motor speeds are dependent on cerebral dopaminergic systems. The neuroscience studies have shown that estrogen influences the release of dopamine in the nigro-striatal pathway. Ovarian hormones have widespread effects throughout the brain, including midbrain serotonergic pathways and cholinergic pathways. The serotonergic system regulation is supposed to be linked to the presence of estrogen and progestin sensitive neurons in the midbrain raphe. The ovarian hormones influence upon cholinergic function, which involves induction of choline acetyltransferase and acetylcholinesterase according to a sexually dimorphic pattern. Because of the widespread influences of these various neuronal systems, it is not surprising that ovarian steroids have measurable effects on cognition that are evident after ovariectomy and during aging (3). The high-estrogen phases of the menstrual cycle were found to be associated with enhanced left-hemisphere processing and low-estrogen phases were associated with better right-hemisphere processing (4). Gonadal steroids not only have reproductive functions but also display neuroactive effects. These are thought to be responsible for changes in mood and cognition over the course of the menstrual cycle, during pregnancy, and after menopause (5, 6, 7). During menses, levels of estradiol and progesterone are low, the follicular phase is characterized by high estradiol levels, while during the luteal phase, concentrations of both hormones are high (8, 9). The menstrual cycle has varying levels of hormones, so it is hypothesized that reaction time alters during normal menstrual cycle. Our study is an effort to determine whether there is any alteration of simple visual reaction time [VRT] during the normal menstrual cycle.

MATERIALS AND METHODS

Our study was conducted in the department of Physiology, M.R. Medical College Gulbarga in the year 2011 after obtaining permission from the Institutional Ethical Committee. The study involved 100 female first year medical and dental students within age group of 17–20 years. Only girls with history of regular menstrual cycle of 28–30 days duration for at least last six months and with normal vision were selected.

Male subjects and female subjects with color blindness, visual defects, irregular menses, gynecological problems, Premenstrual Syndrome, any hormonal treatment, other medication, sleep disorders and hand deformities were screened and excluded from the study. All subjects were instructed to daily chart their basal body temperature during the entire study period.

The reaction time apparatus is a portable research

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reaction timer with 2 response choices bought from Anand agencies, Pune-2, which can measure VRT. The specifications of the reaction timer include an inbuilt 4 digit chronoscope with least count of 1/1000 seconds and works on 230 volts AC.

The tests were carried out in illuminated and well ventilated room in sitting posture between 10:00 am to 12:00 pm. All subjects were thoroughly acquainted with apparatus and 3 readings were taken after practice and trials for Red and Green color for visual reaction time.

The subjects were aware about the type of stimulus being presented and they were asked to press the response button with index finger of their dominant hand and respond immediately on seeing the light stimulus by removing the finger from button on subject's panel. Reaction time was read directly from digital display. The reaction time was recorded on:

1. 1-2 days prior to the expected date of menstruation [premenstrual phase].
2. 1-3 days of menstruation [menstrual phase].
3. Middle of proliferative phase (10th – 12th day).
4. On the expected day of ovulation (BBT showing rise) [ovulatory phase].
5. Middle of secretory phase (21st–23rd day).

The results were expressed as Mean±SD and the data was analyzed using statistical test named Student's paired t-test for comparison of the means. 'p' value of less than 0.05 was considered significant.

RESULTS

Table. I shows study group consisting of 100 subjects with mean age18.04±1.01 years, age range 17 - 20 years, mean weight 50.56±6.82kgs, weight range between 38 -67kgs, and mean BMI 21.63±4.10kg/m^2.

Table. 1: General Characteristics of the study subjects.

Parameters	Study Group
Age(years)	18.04±1.01
Weight (kg)	50.56±6.82
BMI(kg/m^2)	21.63±4.10

Results are expressed as Mean ±SD.

Table. II: Visual reaction time (VRT) of subjects in different phases of menstrual cycle.

Phases of menstrual cycle	Mean ±SD (msec)	P value
Premenstrual phase	233.37±50.63	0.048*
Menstrual phase	221.88±31.92	0.081
Mid-proliferative Phase	212.22±41.58	0.049*
Ovulatory phase	223.48±33.17	0.010*
Mid-secretory phase.	210.64±34.25	0.010*

Results are expressed as Mean ±SD [*p value <0.05 is considered significant]

Table II shows that VRT was highest in pre-menstrual phase [233.37 msec] and lowest in mid secretory phase [210.64 msec]. There was a significant increase in VRT during premenstrual phase as compared to that in the adjacent phases i.e. menstrual phase (P=0.048) and secretory phase (P=0.010). Also in the ovulatory phase VRT increased significantly as compared to its adjacent phases i.e. proliferative (P=0.049) and secretory phase (P=0.010).

DISCUSSION

Reaction time indicates the time interval between the onset of the stimulus and the initiation of response under the condition that, the subject has been instructed to respond early and rapidly. It evaluates the processing speed of central nervous system and the coordination between the sensory and motor systems (10). Reaction time measures the latency in sensory neural code which traverse 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 (i.e. muscle activation) (11). So any change in reaction time indicates presence of a peripheral and/ or central disturbance.

Neurophysiologic studies have shown that the brain regions involved in affective state as well as cognition are widely affected by ovarian hormones (3). The estrogen and progesterone undergo cyclic changes in a normal menstrual cycle.

In the Proliferative phase there is decrease in production of progesterone and gradual increase in estrogen. In the ovulatory phase, there is exponential increase in estrogen levels. After the ovulation, progesterone levels also begin to rise.

During the secretory phase, estrogen and progesterone are increased but progesterone is increased more. In premenstrual phase both the hormones decrease (12). It is known that the hormonal changes during menstrual cycle have fluctuating levels of estrogen and progesterone that might affect the reaction time.

Studies of weight changes and balances of sodium, water and potassium across normal menstrual cycle have shown occurrence of sodium and water retention in premenstrual phase (13). Various mechanisms like progesterone withdrawal, increased secretion of aldosterone and Anti Diuretic Hormone during premenstrual phase have been postulated to be responsible for these changes (14). This retention of water and sodium might influence the process of axonal conduction and availability of neurotransmitter at synapses, resulting in delayed conduction and hence increased reaction time in premenstrual phase (15).

Estrogen may enhance the inhibitory effects of GABA by stimulating its secretion during estrogen peak mid cycle phase and thereby delaying conduction.

Progesterone may cause decrease in the sensitivity of neurons and blunt the estrogen potentiated release of GABA (14, 16). Thus it is in accordance with our present finding of significant increase in VRT during ovulatory phase where estrogen concentration is highest (16). This also explains changes in VRT during other phases of menstrual cycle like mid secretory when changing levels of estrogen and progesterone are considered.

During high estradiol and progesterone levels, the involuntary cortical arousal response to incoming stimuli is reduced. At times of low sex hormone concentrations (during menses), the mental classification of deviant stimuli appears to be faster whereas it was slower during the follicular and luteal phases. Also no performance differences were observed across the menstrual cycle. While this finding fits to the known inhibitory actions of progesterone, it appears to be in contrast to the reported neuro-excitatory effects of estradiol as demonstrated in humans with EMG and therefore needs experimental replication (17, 18, and 19).

We can conclude that fluctuating levels of estrogen and progesterone during the normal menstrual cycle influence visual reaction time which indirectly measure sensory and motor association of an individual. This above fact can be taken into consideration with respect to neurological and behavioral assessment of women. Ours is a preliminary study on a small number of subjects. Substantiation of its results by measuring the hormonal levels over the menstrual cycle in large number of subjects is recommended in further studies.

ACKNOWLEDGEMENT

This research is made possible by the support from the participants of our study. We dedicate our acknowledgment of gratitude towards Mr. Shaik Meera and Dr. Manjushree Sugoor as they kindly read our paper and offered valuable detailed advices on grammar, theme of the paper and organization. Finally, we sincerely thank almighty, family who provided financial support and timely advice.

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Source of support: Nil
Conflict of interest: None Declared