

## **Parasympathetic Functions Study during Different Phases of Menstrual Cycle**

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**Abstract:** A study undertaken to study parasympathetic responses with various tests like resting heart rate, sinus arrhythmia, postural index and Valsalva index on ECG during different phases of menstrual cycle. The study was conducted on 30 healthy female medical students with the age group of 17-25 yrs.

**R-R interval, E: I index and postural index** does not show any statistically significant results indicating that parasympathetic activity remains unaffected throughout the menstrual cycle. But the balance between the sympathetic and parasympathetic alters during premenstrual phase, as Valsalva index which reflects balance between two is significant. Hence it is likely that an exaggerated response to hormonal changes during menstrual cycle may be responsible for significant results.

**Key words:** parasympathetic functions, R-R interval, E: I index, Postural index, Valsalva index.

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### **I. Introduction**

The ANS supervises the internal environment of the body by receptors i.e. baroreceptors, Chemo and mechanoreceptors which compare constantly the actual values with set points in a closed control loop to keep the homeostasis as constant as possible. Internal and external influences such as physical activity, food intake and thermal changes are immediately balanced by specific adaptation i.e. modulated respiration, HR and BP induced by ANS.

The autonomic nerves have a pivotal role in the regulation of the cardiovascular system. The study of the cardiovascular variation is mainly assumed to access the activity of the sympathetic and parasympathetic nervous activity (1). Recently there has been much interest in the psychological and biological correlates of the responsiveness of the Cardiovascular System to environmental events. The variable that may be related to parasympathetic reactivity among women is the fluctuation of reproductive hormones during the menstrual cycle (2). Therefore the parasympathetic control of the heart in relation to endogenous hormonal fluctuation is part of the focus of this study.

Several simple non-invasive tests of Parasympathetic functions have been described (3, 4). These tests are based on measurement of reflex changes in heart rate in response to standardized stimuli such as the Valsalva maneuver (5), repeated deep breathing standing etc (6, 7). These tests provide additional information about parasympathetic control of the cardiovascular system. The various tests provide unique opportunity for the precise definition of the location of abnormality in the autonomic nervous system.

Certain autonomic changes have been reported during the premenstrual phase. It is likely that an exaggerated response to hormonal changes may be responsible for variable physical and psychological symptoms (8). More than one factor apparently is involved in some way or the other. Therefore correlating autonomic nervous changes with phases of menstrual cycle is but logical.

The aim of the present study is to examine parasympathetic response to physical stressors like deep breathing postural change, valsalva maneuver on ECG, during the premenstrual, menstrual and postmenstrual phases of the menstrual cycle.

### **II. Materials And Methods**

The study was conducted in a major teaching college and hospital in Mumbai with the prior permission of the Dean of the institute and the ethical committee. Thirty female medical students within in the age group of 17-25 years were subjected to a series of tests exercising utmost care in conduction so as to achieve the maximum possible accuracy with the available setup. A brief explanation to subjects regarding the procedure was given and voluntary informed consent of the subjects was taken.

The girls with regular menstrual cycle of 21-35 days duration, having no, medical or gynecological problems, no well-defined premenstrual tension were selected for the study. The subjects were asked to abstain from any medication likely to affect or influence PMS (diuretics, vitamins, hormone, etc.) or drugs affecting moods (antidepressant, tranquilizers). Prior to the study all subjects completed a healthy history questionnaire and a medical examination.

**Resting Heart Rate:**

Each subject was made to lie down on a couch and after a rest of at least 5 minutes the resting pulse rate were recorded in lying posture. The heart rate was calculated from an electrocardiogram recorded on a portable machine the “Cardiomin 2”. Subsequently 2 further readings were taken 5 minute intervals and the test was started after 2 consecutive readings were the same. This meant that in all probability the parameters reached their resting value and that they had each relaxed for the same time before the test was started.

**Sinus Arrhythmia:**

This is the variation in heart rate with deep breathing. While the subject is lying supine she was asked to breathe slowly and deeply at the rate of 6 to 8 breaths per minute with each phase of respiration i.e. inspiration and expiration lasting for 5 seconds each. Timing was adjusted with a metronome. After few practice rounds on an ECG tracing was taken. The heart rate increases during inspiration and decreases during expiration. On the recorded ECG strip the R-R interval increases during expiration and decreases during inspiration. The ratio of this R-R interval during expiration versus inspiration is called the E: I Index.

$$\text{E: I Index} = \frac{\text{Maximum R-R interval in mm (during expiration)}}{\text{Minimum R-R interval in mm (during inspiration)}}$$

**Postural Index:**

Postural Index is a measure of autonomic functions. Postural index may be defined as the beat to beat variability recorded during the immediate heart rate response to standing from a supine position. Only limb leads of the ECG were attached to the subject and the subject was asked to stand up with her feet on a mat placed beside the couch, causing the least possible movement in order to avoid motion artifacts on the ECG tracing within a period of 5 seconds. Mean while a continuous ECG record was taken from the time the subject started getting up to a few seconds after standing still. In normal subjects there is characteristic immediate shortening of the R-R interval that is maximum around the 15<sup>th</sup> beat after standing followed by a relative lengthening that reaches a maximum around the 30<sup>th</sup> beat after standing i.e. tachycardia around the 15<sup>th</sup> beat and bradycardia around the 30<sup>th</sup> beat, thus giving a ratio of 30:15

$$\text{Postural Index} = \frac{\text{Maximum R-R interval at 30}^{\text{th}} \text{ beat}}{\text{Minimum R-R interval at 15}^{\text{th}} \text{ beat}}$$

**Valsalva Index:**

To perform the Valsalva maneuver the subject was asked to sit and blow into the rubber tube of a mercury sphygmomanometer, raise the mercury column to 40 mm Hg and maintain that level for at least 30 seconds. Continuous ECG tracing was recorded during the whole procedure.

The valsalva index was calculated as follows.

$$\text{Valsalva index} = \frac{\text{Maximum R-R interval in mm (during release)}}{\text{Minimum R-R interval in mm (during strain)}}$$

The above parameters were used to study the parasympathetic responses during different phases of menstrual cycle. The tests were carried out during 3 phases of menstrual cycle. Taking into consideration regularity of the menstrual cycle and basal body temperature, the phases marked of out were:

1. Menstrual phase (1<sup>st</sup> -5<sup>th</sup> day) i.e. from the day 1 when bleeding started.
2. Post menstrual phase(6<sup>th</sup>- 11<sup>th</sup> day)
3. Pre-menstrual (20<sup>th</sup>-25<sup>th</sup> day) (8, 9, 10, 11, 12, 13).

The female subjects had regular menstrual cycles for 6 months prior to the Study During the test, girls also had fill in a daily questionnaire of the mood state, drug consumption if any. The analysis of endogenous hormones to mark menstrual cycle phases was not done, as the regularity of menstrual cycle was strictly followed and the tests were done during the bleeding days(Menstrual phase), immediate after completion of menstruation i.e. on 6<sup>th</sup> to 11<sup>th</sup> day(Post menstrual phase) and just before the next menstruation i.e. on 20<sup>th</sup>-25<sup>th</sup> day(premenstrual phase).

**III. Results And Observations**

A comparison of the parasympathetic functions during these phases of the menstrual cycle was done in females with a mean age of 19 years. The result of this study were based on a statistical evaluation using the “t” Test”.

**Table No 1: Comparison Of R-R Interval In Different Phases Of The Menstrual Cycle**

	No of subjects	Mean of Difference	SD	P Value	Results
Premenstrual V/S Menstrual	30	0.038	0.0648	>0.05	Not significant
Premenstrual V/S postmenstrual	30	0.027	0.0769	>0.05	Not significant

**Table No 2: Comparison Of E:I Index In Different Phases Of The Menstrual Cycle**

	No of subjects	Mean of Difference	SD	P Value	Results
Premenstrual V/S Menstrual	30	0.019	0.1984	>0.05	Not significant
Premenstrual V/S Postmenstrual	30	0.053	0.2201	>0.05	Not significant

**Table No 3: Comparison Of Postural Index In Different Phases Of The Menstrual Cycle**

	No of subjects	Mean of Difference	SD	P Value	Results
Premenstrual V/S Menstrual	30	0.037	0.1260	>0.05	Not significant
Premenstrual V/S postmenstrual	30	0.025	0.1406	>0.05	Not significant

**Table No 4: Comparison Of Valsalva Index In Different Phases Of The Menstrual Cycle**

	No of subjects	Mean of Difference	SD	P Value	Results
Premenstrual V/S Menstrual	30	0.065	0.1443	<0.05	Significant
Premenstrual V/S postmenstrual	30	0.016	0.1635	>0.05	Not significant

- Significant at 5 percent level of significance.
- T(29)=1.7 the parameter were compared during various phases as premenstrual V/s menstrual, premenstrual V/s postmenstrual and menstrual V/s Post menstrual. The comparison of R-R interval, E.I Index and postural index does not show any significant results. The comparison of valsalva index during the premenstrual V/s menstrual phases shows a significant result but non-significant results during premenstrual V/s postmenstrual and menstrual V/s Post menstrual

#### IV. Discussion

In the present study a comparison of the resting heart rate during the various phases of menstrual cycle was done. Significant difference was not seen in HR during these phases. A.S.Chakraborty and V. Mehta (1993) showed that the parameters like heart rate calculated from ECG and phonocardiogram (PCG) did not show any significant change during different phases of menstrual cycle. Gausti et al also suggested that there is an increased sympathetic activity in luteal phase with no changes in parasympathetic activity (14). The present study also showed no change in the parasympathetic activity (8) Based on this discussion it can be concluded the heart rate remained similar throughout the menstrual cycle, as variation in heart rate at rest is mediated by the cardiac vagal or parasympathetic effect. There is normally a fluctuation of heart rate that is synchronous with the respiratory cycle. The pulse accelerates slightly during inspiration and slows on expiration. This sinus arrhythmia is a normal phenomenon and is due primarily to fluctuations in parasympathetic output to the heart. During inspiration, impulses in the vagi from the stretch receptors in the lungs inhibit the cardio inhibitory area in the medulla oblongata. The tonic vagal discharge that keeps the heart rate slow decreases and the heart rate rise (15). T. Wheeler and P Watkins (1973) suggested that R-R interval variation during deep breathing is under vagal control (efferent) (16). Even O'Brien, O'Hare and JM Corral (1986) showed that during sinus arrhythmia the efferent pathway via the cardiac vagal fibers (17). Thereby the EI index predominantly reflects the parasympathetic activity during different phases of the menstrual cycle.

Changing from lying position to standing produces an integrated reflex response of the cardiovascular system, which includes alteration in the heart rate and blood pressure. The changes in posture might provide a most delicate test of the condition of the vasomotor mechanism. There is a transient fall in blood pressure on standing with stimulation of the Carotid baroreceptors and consequent reflex tachycardia and peripheral vasoconstriction. In the present study comparison was made between the postural index during the premenstrual and menstrual phase and post menstrual phases and there was no statistically significant difference between

these phases. DJ Ewing showed that the initial heart rate response to standing is under vagal control with an immediate vagal withdrawal which increases the heart rate over the first 10-15 beats (tachycardia). This is followed by a vagal reactivation that slows the heart and gives a characteristic rebound bradycardia (6).

V.Mehta (1999) suggested that 30:15 ratio does not show any difference between various phases of the menstrual cycle. This ratio predominantly reflects the parasympathetic activity (8). Hence it is seen that postural index is under vagal control and therefore does not show any significant change during different phases of the menstrual cycle. The Valsalva maneuver was described in 1794 by Antonio M.Valsalva, an Italian Anatomist (37). He originally described it for expelling pus from the middle ear by expiration against a closed glottis (18).

Valsalva maneuver is forced expiration against closed glottis. The blood pressure rises at the onset of straining because the increase in intrathoracic pressure is added to the pressure of the blood in the aorta. It then falls because the high intrathoracic pressure compresses the veins decreasing venous return and cardiac output. The decrease in arterial pressure and pulse pressure inhibit the baroreceptors, causing tachycardia and rise in peripheral resistance. In sympathectomized patients, heart rate changes still occur because the baroreceptors and the vagi are intact (15). The comparison of Valsalva index between premenstrual V/s menstrual phases show significant results but non-significant results were obtained when it was compared between menstrual V/s post menstrual and premenstrual V/s postmenstrual this shows that Valsalva index show significant results during premenstrual phases i.e. luteinizing phase O'Brien and O'Hare (1986) suggested that the Valsalva maneuver elicit a complex scale of hemodynamic events that result in the activation of both sympathetic and parasympathetic neurons. Fuenmayor J, Ramirz L and Fuenmayor AM studied the cardiac autonomic nervous system balance variation during two phases of menstruation. The Valsalva maneuver was performed to test the autonomic function and they concluded that the autonomic nervous system balance suffer significantly during the luteinizing phase of the cycle in normal women (19).

Based on the correlation of the various studies mentioned it can be concluded that the Valsalva maneuver is a reflection of both the sympathetic and parasympathetic activity and that the autonomic nervous system balance is compromised significantly during the luteinizing phase. The present study also shows a similar rise in the Valsalva index during the premenstrual phase and correlates well with other studies.

## V. Conclusion

Parasympathetic activity is not changed during various phases of menstrual cycle as R-R interval, E.I Index and postural index have shown insignificant changes. Valsalva index is a parameter, which reflects balance between both parasympathetic and sympathetic, show significant results in premenstrual phase. It is likely that an exaggerated response to hormonal changes may be responsible for significant results.

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