Autonomic function tests during pre and post menstrual phases in young women

Ashwini N. Nilekar*, Vaishali V. Patil**, Samir Kulkarni***, Mangala Vatve****

Abstract

Women undergo many types of behavioral and hormonal changes especially during reproductive life. Besides reproductive changes there are cyclical fluctuations in various functions of body systems. Autonomic Nervous System provides physiological adaptive background for these changes. The main aim of this study is to carry out standard autonomic function tests during various phases of menstrual cycle and also to assess significance of autonomic function tests .This study was carried out in two different phases of menstrual cycle viz. premenstrual phase (late luteal phase-LL) and post menstrual phase (early follicular phase–EF). In the present study, responses to various sympathetic tests were significantly altered in premenstrual phase as compare to that of postmenstrual phase reflecting the significant increase in the sympathetic activity .These changes may be due to gonadal steroids imbalance during post menstrual phase (EF) and premenstrual phase (LL) of menstrual cycle which in turn affects Hypothalamo Pituitary axis and ANS significantly. Significant increased sympathetic activity responses indicate an augmented stress system.

Key Words: *Autonomic nervous system, Late luteal phase, Early follicular phase, Hypothalamo pituitary adrenal, Sympathetic activity.*

Introduction

All types of behavioral and hormonal changes occur in women especially during reproductive life. In addition to many changes in the reproductive system, there occurs a regular fluctuation in numerous functions affecting all body systems. These can be physical, psychological or behavioral. Autonomic nervous system (ANS) which provides the physiological background for the perceived changes.

Certain autonomic changes have also been reported during menstrual phases. These changes might be due to one or more variables like hormonal levels, physical as well as mental stress, personality characteristics, genetic determinants and social factors which may contribute directly or indirectly.

Most often the cumulative physiological effect of stress causes disruption of the natural rhythms and balancing mechanism of female hormones, there by compromising overall health as well as sexual and reproductive health. Hormonal imbalance affects not only physical health but also psychological health, manifesting as problems ranging from depression to panic disorders. During the perimenopasual period and early menopause, there is a progressive hormonal imbalance which might help to explain the characteristics “hot flushes” and so called climacteric depression.

The behavioral and psychological changes in response to hormonal imbalance during premenstrual phase, pregnancy and menopause involve limbic system and hypothalamus. Most of the behavioral and emotional patterns are exhibited through ANS. Therefore, it is worth while to assess autonomic functions during various phases of menstrual cycle. Testing of autonomic

* Assistant Professor, Department of Physiology, Hi-Tech Medical College, Bhubaneshwar.

**Assistant Professor, Department of Physiology, Rural Medical College, Loni, Maharashtra- 413736.

*** Senior Registrar,Department of Anesthesiology, Hi-Tech Medical College, Bhubaneshwar.

****Ex-Prof. & H.O.D, Department of Physiology, Rural Medical College, Loni, Maharashtra- 413736.

Address for correspondence:

Dr. Ashwini Nilekar

Flat- 302/07, Kalyani, Sahara States,

Mansoorabad, Hyderabad- 500068

Email: ashsamsku@gmail.com

functions will also help to interpret the test results such as whether these changes are within physiological limit or pathological. These would also help to predict any existing autonomic dysfunction during various phases of woman's life.

Material and Methods

The study of autonomic function tests was carried out in two different phases of menstrual cycle i.e. Pre-Menstrual and Post-Menstrual phase.

For this study, 50 healthy female volunteers, aged between 18-25 years were selected. The exclusion criteria were:

1. Volunteers with irregular menses.
2. Volunteers with menorrhagia and oligomenorrhoea.

All the volunteers were assessed for autonomic function tests during premenstrual phase i.e. around 25^{th} -26^{th} day of menstrual cycle and during postmenstrual phase i.e. on 6^{th} -7^{th} day of menstruation.

Physical parameters noted in each volunteer were:
-Age in years.
-Weight in Kgs.

Blood pressure was recorded with sphygmomanometer by auscultatory method. Electrocardiogram (ECG-CARDIART 108T-British physical laboratories India limited) recordings was carried out with Lead II. All tests were carried out in the morning and afternoon hours with the consent of volunteers. After giving rest for 5 minutes, the following parameters were recorded.

Tests for sympathetic function

1. **Pulse rate (per minute)** by palpatory method.

2. **Arterial blood pressure (mm of Hg)** recording by auscultatory method.

3. **Orthostatic variation in arterial blood pressure:**

Procedure: After recording the blood pressure in supine position by auscultatory method, the subject was asked to stand up and after 50 seconds the blood pressure was recorded. Any change in blood pressure is determined as the difference between the recording while supine and standing position.

Result: A decrease in systolic blood pressure >20mm of Hg and decrease in diastolic blood pressure >10mm of Hg during 1 minute standing suggest autonomic dysfunction.

4. Cold pressor test

Procedure: The subject was asked to immerse the hand in ice cold (4^0C) water for one minute and the blood pressure was recorded in supine position by auscultatory method. This maximum blood pressure recording obtained with a hand in 4^0C water was taken as an index of response.

Result: Normally both systolic and diastolic blood pressure should increase at least by 10mm of Hg at the end of 1 minute of immersion.

This is used to evaluate the peripheral sympathetic vasoconstrictor mechanism.

Tests for parasympathetic functions

1. Heart rate response

Procedure: The subject was asked to lie down comfortably and the heart rate was recorded. Then the subject was asked to stand up and immediately the heart rate was recorded. The heart rate was calculated with the help of R-R interval. Response was taken as a difference between the heart rate in supine and standing positions.

Result: Normally heart rate should increase at least by 10 beats per minute in standing position. The absence of increase in heart rate during standing position has been interpreted as an impairment of autonomic function of heart.

2. Expiratory: Inspiratory ratio: (E: I ratio)

Procedure: The subject was asked to lie down comfortably and was asked to take deep breaths slowly in and out, approximately at 6 breaths per minute i.e. 5 seconds inspiration and 5 seconds expiration. The maximum and minimum R-R intervals during each phase of respiration were recorded. The heart rate was calculated and the variation during respiration was observed.

Result: E: I ratio is taken as the ratio of longest R-R interval during expiration to the shortest R-R interval during inspiration. E: I <1.2 is abnormal.

3. Valsalva ratio

Procedure: The subject was asked to take deep breaths with closed nostrils and puff the cheeks simultaneously for 15 seconds and then was asked to release the strain by doing forceful expiration. The heart rate was recorded and calculated during the strain and after release of strain.

Result: Normally heart rate is increased during the strain and this raised heart rate is due to baroreflex stimulation to the fall in the blood pressure seen as a result of increased intrathoracic pressure (decreased venous return). On release of strain the cardiac output is restored and there is an increase in blood pressure. Valsalva ratio is taken as the ratio of longest R-R interval after release of strain to the shortest R-R interval during strain. It is used as an index of cardiac vagal function. A ratio of < 1.2 is abnormal.

Statistical analysis

It was done by student paired "t" test. $P < 0.05$ was considered as statistically significant.

Observations

Table No.1: Comparison of autonomic functions in two different phases

The result of parameters reflecting sympathetic activity

	Premenstrual (LL)Phase (n=50)	Postmenstrual (EL)phase (n=50)	'Z' value	'p' value	Result
	Mean ±SD	Mean ±SD			
Pulse rate (per min)	86.12 ± 4.33	77.0 ± 3.92	11.04	p<0.01	More significant
Supine					
SBP(mm Hg)	113.32 ± 4.59	106.2 ± 4.84	7.55	p<0.01	More significant
DBP(mm Hg)	71.2 ±4.27	65.32 ± 4.67	6.35	p<0.01	
Standing					
SBP(mm Hg)	109.96 ± 5.11	104.28 ± 4.83	5.74	p<0.01	More significant
DBP(mm Hg	79.46 ± 4.39	73.12 ± 4.02	7.53	p<0.01	
Orthostatic variation in blood pressure					
SBP(mm Hg)	-2.18 ± 0.66	-1.72 ± 0.47	2.01	p<0.05	Significant
DBP(mm Hg)	8.26 ± 1.01	7.8 ± 1.12	1.98	p<0.05	Significant
Cold Pressor test					
SBP(mm Hg)	123.24 ± 4.16	115.64 ± 4.25	9.04	p<0.01	More Significant
DBP(mm Hg)	90.1 ±3.94	80.68 ± 2.67	13.98	p<0.01	

Table No.2: Comparison of autonomic functions in two different phases:
The result of parameters reflecting parasympathetic activity

	Premenstrual (LL)Phase (n=50)	Postmenstrual (EL)phase (n=50)	'Z' value	'p' value	Result
	Mean ±SD	Mean ±SD			
Heart Rate Response	16.46 ± 4.92	16.62 ± 5.31	0.16	p>0.05	Not significant
Expiratory: Inspiratory Ratio	1.43 ± 0.23	1.40 ± 0.29	0.45	p>0.05	Not significant
Valsalva Ratio	1.15 ± 0.065	1.16 ± 0.08	1.16	p>0.05	Not significant

In Table No.1, the autonomic function tests for sympathetic activity were compared during pre and post menstrual phases. It was observed that pulse rate, blood pressure and cold pressor test were statistically more significant ($p<0.01$), while orthostatic variation in arterial blood pressure was statistically significant ($p<0.05$) in premenstrual phase as compared to post menstrual phase of menstrual cycle.

In Table No.2, the autonomic function tests for parasympathetic activity were compared during pre and post menstrual phases. It was observed that heart rate response, expiratory: inspiratory ratio and valsalva ratio were statistically not significant ($p>0.05$) in both pre and post menstrual phases of menstrual cycle.

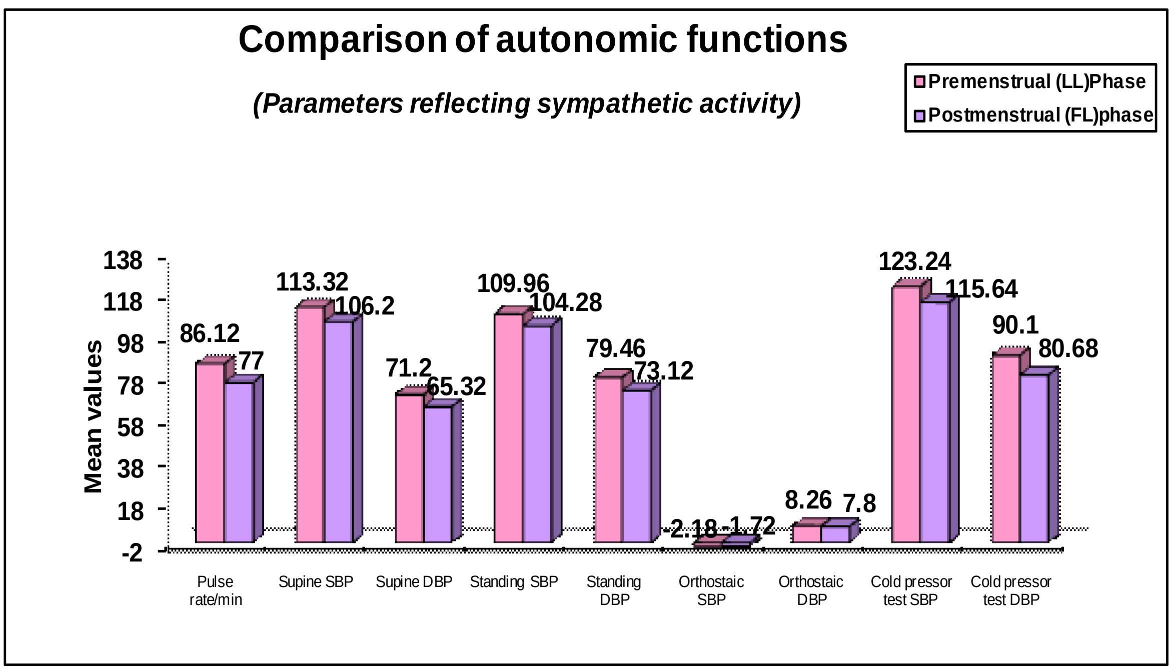

Fig 1a: Showing comparision of autonomic functions

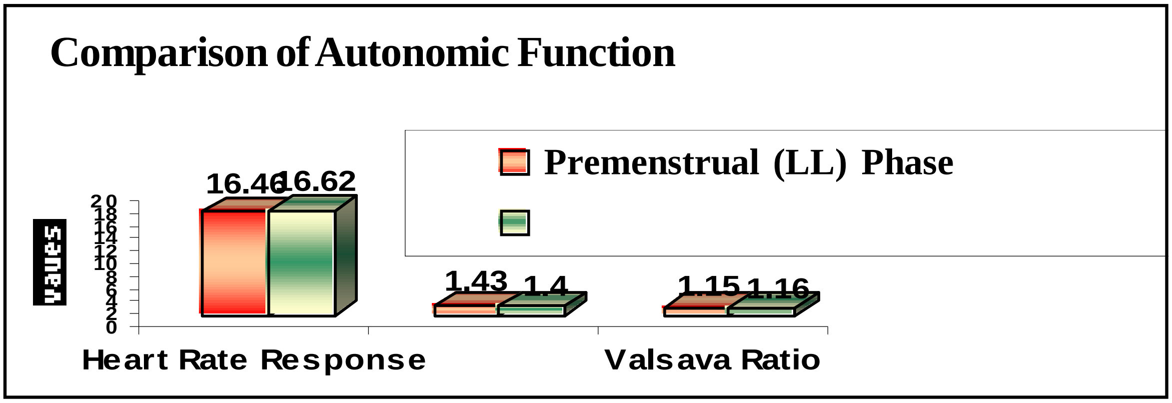

Fig 1b: Showing comparision of autonomic functions

Discussion

In the present study the premenstrual phase was taken as late luteal (LL) phase of menstrual cycle and postmenstrual phase as an early follicular (EL) phase of menstrual cycle. The hormonal changes to regulate the menstrual cycle were associated with physiological and psychological changes in women.

In the present study, responses to pulse rate, orthostatic variation in arterial blood pressure and cold pressor test were significantly ($p<0.05$) altered in premenstrual phase as compared to that of postmenstrual phase, reflecting a significant increase in sympathetic activity.

This can be explained on the basis that-female reproductive steroids are modulators of HPA axis, which in association with ANS, form the stress system which regulates homeostatic mechanisms of the body. This HPA axis that is CRH induced proopiomelanocortin peptide inhibits GnRH secretion from hypothalamus which in turn affects the ovarian estrogen and progesterone levels.[1] The gonadal hormones fluctuation during the menstrual cycle is associated with significant changes in multiple neurohumoral homeostatic mechanisms of the body.[2]

Estrogen increases sympathetic baroreflex sensitivity and also has a prolonged stimulatory action on CRH gene promoter and central non adrenergic system which indicates changes in sympathetic activity responses significantly more during premenstrual (LL) phase than postmenstrual (EF) phase.[3]

The changes in sympathetic activity might be due to one or more variables like hormonal levels (changing influence of ovarian steroids in different phases), personality characteristics, genetic determinants and social factors which may contribute directly or indirectly.[4]

A large number of studies in relation to the menstrual cycle were carried out by earlier workers but no consistent picture could be emerged.[5, 6, 7,8,9,10,11] It was observed that some studies which used multiple variables like the present study also showed an increased sympathetic activity in premenstrual phase. An excellent review of different studies of physical and psychological changes throughout the menstrual cycle in three forms, namely the behavioral, autonomic and cortical was done.[7]

It was concluded that changes occurring in premenstrual phase were sympathetic alike[12] and was also revealed that tension and anxiety were reliably associated with an autonomic arousal.[13]

It was observed that there were significant responses to orthostatic variation in arterial blood pressure, cold pressor test in the premenstrual period indicating an increased sympathetic activity with no change in parasympathetic activity.[5]

It was proved that there was a prevalence of 60.7% for autonomic reaction in the premenstrual period.[4]

Some studies used different variables for testing the autonomic functions than that of the present study but the results were consistent in both the studies, though the autonomic variables studied in present study were different from other studies.

The autonomic variables like sublingual temperature, diastolic blood pressure, palmar and volar conductance and salivary output were studied. It was observed that during menstrual, follicular and ovulatory phases responses were higher, showing a parasympathetic dominance, whereas during luteal phase responses were lowest suggesting a sympathetic dominance.[15]

In contrast to present study, some studies found no differences in autonomic reactivity in different phases of menstrual cycle.[16,17,18] The subjects were tested premenstrualy and postmenstrualy for their autonomic reactivity during stress (cold pressor test, mental arithmetic) and for their acquisition of conditioned electro-dermal responses and found no difference in the two phases[18]. It was also claimed that no consistent cyclic variation of autonomic variables occurred in women and this discrepancy between results may be because of the difference in the variables tested and the methods employed for determining the sympathetic and parasympathetic activities.[16, 17]

It was found that there were no changes in autonomic reactivity in the premenstrual phase[19, 20,21] this difference in result may be because of a single autonomic variable like only heart rate or skin potential or skin conductance was tested in other studies, while in the present study, multiple variables were tested.

HPA axis + ANS

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Stress system

↓

Regulate homeostatic mechanism of body

↓

HPA–CRH induced proopiomelanocortin peptide

↓

Inhibits GnRH secretion from hypothalamus

↓

Decrease pituitary LH and FSH

↓

Affects ovarian estrogen and progesterone levels

↓

	EF	LL
Estrogen	⇑	⇑
Progesterone	↓	⇑

Implication

Though young women of present study did not complain of any physical or psychological symptoms during premenstrual phase, yet significantly increased sympathetic activity responses indicate an augmented stress system. Today, young women are under many kinds of stress which may be precipitated during LL phase of menstrual cycle. Further study is required to correlate ANS functions with hormonal imbalance showing significant fluctuation in reproductive steroids. e.g. in anovulatory menstrual cycle, menorrhagia.

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