Indian Journal of Clinical Anatomy and Physiology 2020;7(1):8–11

Content available at: iponlinejournal.com

Indian Journal of Clinical Anatomy and Physiology

Journal homepage: www.innovativepublication.com

Original Research Article

Comparative study of heart rate variability, heart rate and blood pressure in different phases of menstrual cycle in healthy young women aged 22-40 years

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ARTICLE INFO

Article history:
Received 13-01-2020
Accepted 05-02-2020
Available online 14-03-2020

Keywords:
Heart rate variability
Menstrual cycle
Frequency domain analysis
Autonomic nervous system

ABSTRACT

Introduction: Heart Rate Variability analysis has gained much importance in recent years, as a technique employed to explore the activity of autonomic nervous system (ANS), and as an important early marker for identifying different pathological conditions. Autonomic nervous activities fluctuate during the menstrual cycle.
Aims and Objectives: The aim of the present study was to compare and evaluate the changes in the ANS activity measured by the frequency domain analysis during different phases of menstrual cycle.
Materials and Methods: The subjects consisted of 50 healthy adult females aged 22-40 years who had regular menstrual cycles. The electrocardiogram (ECG) recordings were taken during the different phases of the menstrual cycle. Heart rate variability (HRV) was analyzed by means of two main frequency components that is the low frequency (LF) and the high frequency (HF) components using appropriate software. Heart rate (HR) and blood pr essure (BP) were also recorded.
Results: In the frequency domain analysis, the low frequency component (LF) was significantly higher ($p<0.01$) during the luteal phase and the high frequency component (HF) was significantly higher ($p<0.01$) in follicular phase. The LF/HF ratio was significantly greater in ($p<0.01$) the luteal phase compared to follicular and menstrual phases ($p<0.001$). Changes in Heart rate (HR) were maximum in the luteal phase and minimum in the follicular phase. Blood pressure (BP) did not show any significant change during different phases of menstrual cycle.
Conclusion: These findings indicate that sympathetic nervous activity in the luteal phase is greater than in the follicular phase, whereas parasympathetic nervous activity is predominant in the follicular phase.

1. Introduction

The cyclical changes that occur in female reproductive system are commonly termed as menstrual cycle. Men struation is only one manifestation of the ovarian cycle which is itself associated with more than 200 physical, psychological and behavioral changes.

The menstrual cycle is an integral part of a major portion of a woman's life. The reproductive system of a female, unlike that of a male, shows regular cyclic changes that teleologically may be regarded as periodic preparation for fertilization and pregnancy. Ovarian hormones alterations along the menstrual cycle are associated with corresponding significant changes in multiple neurohumoral homeostatic mechanisms regulating the cardiovascular system.[1]

Heart rate variability (HRV) analysis has been extensively used as a tool to examine the underlying mechanisms involved in autonomic control of the heart.

The sympathetic and parasympathetic branches of the autonomic nervous system (ANS) regulate the activity of the sinoatrial node, the cardiac pacemaker.[2] The beat-to-beat variation in heart rate therefore reflects the time varying influence of the ANS and its components, on cardiac function.[3,4] HRV analysis can assess the overall cardiac health and the balance between sympathetic and parasympathetic regulation on cardiac activity. Gonadotropic hormones are

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https://doi.org/10.18231/j.ijcap.2020.002

known to affect this balance. This method has proved to be of great clinical usefulness in studying several pathological conditions due to the hormonal imbalance in women.[5]

The two common forms of HRV analysis are often designated as time-and frequency-domain measures. Time domain measures are the means and standard deviations of R-R intervals recorded by the continuous ECG, where NN (normal-to-normal) intervals represent all the R-R intervals. One of the variables of time domain measures the SDNN, which reflects all the cyclic components responsible for variability in the period of the recording. The SDNN estimates overall HRV.[6,7] A decrease in SDNN has been associated with sudden cardiac death. Spectral analysis of a series of successive R-R intervals provides the frequency domain analysis. This technique separates the heart rate spectrum into various components and quantifies sympathetic and vagal influences on the heart. The high frequency (HF) generally represents parasympathetic activity and is therefore generally considered to be a marker of vagal activity whereas, the low frequency (LF) is influenced by both sympathetic and parasympathetic activity. The ratio of LF:HF represents the balance of parasympathetic and sympathetic activity. Time domain measures help in assessing the magnitude of the temporal variations in the autonomically modulated cardiac rhythm whereas; the frequency domain analysis provides the spectral composition of these variations. The cyclic changes in estradiol and progesterone levels modulate physiological functions. However the relation between the menstrual cycle and the vegetative control of the heart remains disputable due to the lack of studies. Guasti , et al., Sato, et al., and Yildirir, et al., suggested an enhanced sympathetic activity in the luteal compared with the follicular phase.[8,9] These studies suggest that, there are definite changes in the HRV in the different phases of the menstrual cycle. The present study was aimed to quantify the difference in the HRV analysis using frequency domain methods in different phases of menstrual cycle.

2. Materials and Methods

A total of 50 teaching and non teaching staffs of CIMS, Chamarajanagar were selected as study subjects. The selected subjects were in the age group 22-40 years who were having regular, 28-day menstrual cycles for at least 6 months prior to this study. After detailed enquiry of the medical history of the subjects, those with history of smoking, alcoholism, medical illness were excluded. Subjects on oral contraceptive pill, hormonal replacement therapy, drugs that alter the cardiovascular functions were also excluded from the study. Informed written consent was obtained from all participants, and the experiment protocol was approved by Ethics Committee of the college.

The experiments were carried out in the morning in fasting state. Subjects refrained from caffeinated beverages for at least 12 hours prior to the experiments and had completed their evening meal by 9 P.M. They were also instructed to avoid strenuous physical activity from the previous evening.

The ECG recordings were taken during the 3 phases - menstrual phase (1st to 5th day of bleeding), follicular phase (6th day to 14th day of menstrual cycle) and luteal phase (15th day to 28th day) of menstrual cycle by means of HRV power spectral analysis using Niviqure Computerised ambulatory ECG system (ECG V; 52 Manufactured by NIVIQURE Meditech pvt. Ltd. Bengaluru and marketed by Inco Medicals; Ambala. Manufactured year-2006) and the two main frequency components that is the low frequency (LF) components (0.04 to 0.15Hz) and the high frequency (HF) components (0.15 to 0.4 Hz) were measured and LF/HF ratio was analyzed.

To quantify heart rate, the analog ECG signal was obtained using lead II to obtain a QRS complex of sufficient amplitude and stable base line. Blood pressure was recorded using Digital electronic blood pressure monitor.

2.1. Statistical analysis

The stastical analysis was done using ANOVA (Analysis of variance), and student's unpaired T test. P value less than 0.001was taken as significant.

3. Results

I. HRV analyzed using frequency domain methods:

Mean base line levels during the menstrual, follicular and luteal phase was 40.4±16, 46.2±14 and 60.8±73 for LF component, 52.15±10.61, 60.96±14.58 and 42.41±17.92 for HF component and 0.68±0.54, 1.08±0.36 and 1.92±1.05 for LF/HF ratio respectively.

LF component was significantly higher ($p<0.01$) during the luteal phase and HF component was significantly higher ($p<0.01$) in follicular phase.

The LF/HF ratio was significantly greater ($p<0.01$) in the luteal phase compared to follicular and menstrual phases ($p<0.001$).

II. Changes in heart rate were maximum in the luteal phase and minimum in the follicular phase.

III. Blood pressure did not show any significant change during the different phases of menstrual cycle.

Table 1: LF analysis in different phases of menstrual cycle (N=50).

Phase	Mean ±SD
Menstrual	40.4±16
Follicular	46.2±14
Luteal	60.8±73

Table 2: HF analysis in different phases of menstrual cycle (N=50).

Phase	Mean ±SD
Menstrual	52.15±10.61
Follicular	60.96±14.58
Luteal	42.41±17.92

Table 3: LF/HF analysis in different phases of menstrual cycle (N=50).

Phase	Mean ±SD
Menstrual	0.68±0.54
Follicular	1.08±0.36
Luteal	1.92±1.05

Table 4: HR analysis in diff erent phases of menstrual cycle.

Phase	Mean ±SD
Menstrual	84±12
Follicular	76±54
Luteal	98±16

Table 5: BP analysis in different phases of menstrual cycle

Phase	Mean ±SD	
	SBP	DBP
Menstrual	124±14	82±10
Follicular	120±22	78±14
Luteal	126±12	80±12

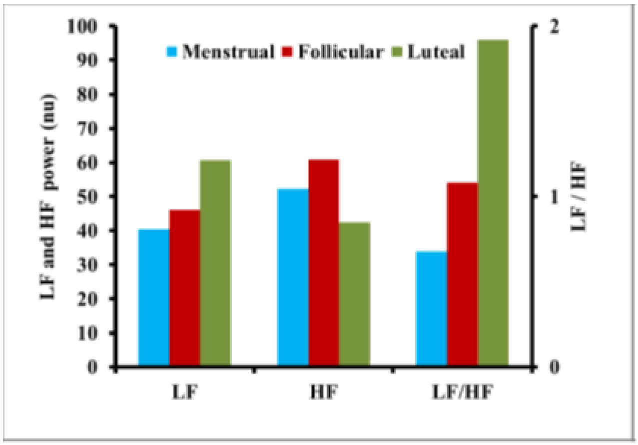

Fig. 1: Normalized components of HRV in different phases of menstrual cycle

4. Discussion

In the female reproductive physiology, the maturation of the female gamete, the egg occurs in the ovary. Its release from the ovary- ovulation is cyclical. These cycles in humans is called menstrual cycle.[10,11]

In terms of ovarian functions the menstrual cycle is divided into 2 phases namely the follicular phase and the luteal phase. This is followed by menstruation which is the most obvious event of a menstrual cycle. The hormonal interaction between the ovaries, hypothalamus and anterior pituitary gland produce the cyclical changes in the ovary.[12,13]

Ovarian hormone alterations along the menstrual cycle are associated with corresponding significant changes in multiple neurohumoral homeostatic mechanisms regulating the cardiovascular system.[14,15]

HRV in women has been related independently to endogenous sex hormones, hormone replacement therapy, menopause, menstrual cycle, body mass index (BMI), and physical conditioning.[16,17]

HRV analysis has gained much importance in recent years, as a technique employed to explore the activity of ANS, and as an important early marker for identifying different pathological conditions.[18,19]

Several studies already compared the HRV in different menstrual cycle phases, but with methodological differences. Most investigators suggested a modulated vegetative control based on some selected HRV results whereas one author did not find any HRV modulations in the time and the frequency domain in course of the menstrual cycle.[1,20] Due to these disagreements and the differences between the studies, the HRV was investigated by short time ECG recording at rest in the present study.

In the present study, the HRV analysis using frequency domain showed a significant increase in the LF component in the luteal phases when compared to follicular and menstrual phase.

Further, the HF component in the menstrual phase was significantly greater than luteal phase. This study provides findings that the luteal phase of the menstrual cycle was associated with a greater increase in the LF component and a greater decrease in the HF component, resulting in a higher LF/HF ratio.

Whereas, the HF component in the follicular phase was significantly higher than the luteal phase.

5. Conclusion

These findings indicate that sympathetic nervous activity in the luteal phase is greater than in the follicular phase, whereas parasympathetic nervous activity is predominant in the follicular phase.

A difference of the balance of ovarian hormones may be responsible for these changes of autonomic functions during the menstrual cycle.

6. Source of funding

None.

7. Conflict of interest

None.

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Cite this article: Rani Y S U, Venkatesh G . Comparative study of heart rate variability, heart rate and blood pressure in different phases of menstrual cycle in healthy young women aged 22-40 years. *Indian J Clin Anat Physiol* 2020;7(1):8-11.