National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Heart rate variability in different phases of menstrual cycle among healthy medical students of a teaching institution, South India

Tinju James, Nayana Sunil

Department of Physiology, Amala Institute of Medical Sciences, Thrissur, Kerala, India

Correspondence to: Tinju James, E-mail: tinjuabel@gmail.com

Received: March 01, 2020; **Accepted:** March 22, 2020

ABSTRACT

Background: Cardiac autonomic function in females depends on the fluctuations in the level of endogenous sex hormones during menstrual cycle. Heart rate variability (HRV) is a non-invasive test that helps to assess the function autonomic nervous system mainly the sympathovagal balance. **Aims and Objective:** The aim of the study was to evaluate the HRV in different phases of menstrual cycle in healthy females of a teaching institution, South India. **Materials and Methods:** A cross-sectional study was conducted among 19 regularly menstruating females in the age group of 18–24 years of age after taking informed consent and institutional ethical clearance. Sympathovagal balance was assessed using HRV analysis in the proliferative and secretory phases of menstrual cycle. **Results:** This study observed an increase in low frequency (LF) in normalized units domain as well as/high frequency (HF) ratio in the secretory phase and an increase in the HF normalized units domain in the proliferative phase, though statistically non-significant. A significant increase in the resting heart rate was noted among the secretory phase compared to the proliferative phase of menstrual cycle ($P < 0.001$). **Conclusion:** An increased sympathetic activity during secretory phase and an increased vagal activity in the proliferative phase were observed, which could be explained due to the fluctuating levels of sex hormones. The knowledge about the sympathetic modulation in the secretory phase can explain the symptoms of premenstrual syndrome, which can in turn improve the quality of life among females.

KEY WORDS: Sympathovagal Balance, Heart Rate Variability, Proliferative, Secretory

INTRODUCTION

Menstrual cycle is divided into three phases based on the hormones estrogen and progesterone released from the ovary as well as by the follicle-stimulating hormone and luteinizing hormone from the anterior pituitary. The phases include menstrual phase, proliferative, and secretory phase.[1] Fluctuations in these hormone levels are found to be responsible for changes in the physiological parameters as well as performance.[2] Animal studies have shown that estrogen acts centrally to cause a reduction in sympathetic activity and increases in vagal activity which is said to have a cardioprotective effect, whereas progesterone tend to have an opposing effect.[3,4] Therefore, variations in these hormone levels can attribute to the autonomic modulation happening during the different phases of menstrual cycle.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2020.10.03064202022032020	

Heart rate variability (HRV) reflects the variation in the time interval between heart beats, which is a physiological phenomenon. Electrocardiogram (ECG) is considered as a superior method to detect heart beat among several methods as it can provide a clear waveform to analyze RR interval and also to exclude heart beats not originating in the sinoatrial node.[5] HRV analysis is a non-invasive technique that helps to assess the

function autonomic nervous system that is to assess the balance between sympathetic and parasympathetic (vagal) activity.[6] Sympathetic impulses increase heart rate while parasympathetic system decreases heart rate by its actions on the SA node.[7]

Although several studies have done to assess HRV in different population, the results were confounding. Vishrutha *et al*.[8] noticed a higher sympathetic control during the proliferative phase of menstrual cycle, where as a greater parasympathetic influence during luteal phase. Brar *et al*.[9] concluded a higher parasympathetic control during proliferative phase of menstrual cycle. There should be a better understanding of the cardio-vagal activity in healthy Indian females, which will help to improve the quality of life. This study aimed to evaluate the HRV in different phases of menstrual cycle in healthy females of a teaching institution, South India.

MATERIALS AND METHODS

A cross-sectional study was conducted among regularly menstruating healthy females of 18–30 years of age. A total of 19 students were enrolled in the study after getting informed consent. Institutional ethical clearance was obtained for the same. Those with history of irregular menstrual cycles, hypertension, diabetes mellitus, cardiorespiratory disorders, practicing yoga, or any respiratory exercises were excluded from the study. Anthropometric measurements, resting heart rate, and blood pressure were taken and HRV was assessed for 15 min in supine resting position with eyes closed after connecting the limb leads of ECG using PHYSIOPAC. Two recordings were taken on 2 specific days of menstrual cycle that is first recording in any one of the day in proliferative phase (day 5–day 14) and another one in one of the day of the secretory phase (day 15–day 28).

HRV thus obtained was analyzed based on time and frequency domain parameters. The frequency domain parameters studied were low frequency in normalized units (LF nu), high frequency in normalized units (HF nu), and the ratio of LF to HF (LF/HF ratio). LF and high frequency spectral powers were determined by integrating the power spectrum between 0.04 and 0.15 Hz and between 0.15 and 0.4 Hz, respectively.

Statistical Analysis

The collected data were analyzed using SPSS Version 23. The data were represented as mean ± standard deviation. The data obtained during both phases of menstrual cycle were compared. The data obtained during the two phases were compared by paired Student's "*t*"-test.

RESULTS

A total of 19 female students were enrolled in the study and the mean age of the study population was 21.16 ± 1.21 years. The mean height (meters), body weight (kg), and BMI (kg/m2) of the study group were 1.60 ± 0.70, 55.64 ± 8.12, and 21.49 ± 2.40, respectively. The mean duration of their menstrual cycle was 28.58 ± 1.17 days. The anthropometric parameters are given in Table 1.

The resting heart rate (per minute) of the study group in the proliferative and secretory phases was 70.74 ± 6.77 and 76.37 ± 6.51, respectively, and a significant increase in the resting heart rate was noted in the secretory phase compared to the proliferative phase of the menstrual cycle. The study noted a systolic blood pressure (in mm Hg) of 104.95 ± 6.84 and 108.00 ± 7.88 in the proliferative and secretory phases, respectively. The mean value of diastolic blood pressure (in mm Hg) was 71.89 ± 7.84 and 72.32 ± 6.64 in the early and late phase of menstrual cycle. There was no significant difference in systolic and diastolic blood pressure between the two phases of menstrual cycle. The details are given in Table 2.

LF nu domain, HF nu domain, and LF/HF ratio of proliferative phase were 85.21 ± 1.72, 14.67 ± 1.91, and 5.93 ± 0.99, respectively, and in the secretory phase was 85.62 ± 1.63, 14.14 ± 2.06, and 6.20 ± 0.15, respectively. This study observed a non-significant increase in LF nu domain and LF/HF ratio during the secretory phase compared to proliferative phase and a non-significant increase in HF nu domain during the proliferative phase compared to secretory phase. LF nu domain, HF nu domain, and LF/HF ratio of proliferative phase as well as secretory phases is given in Table 3.

DISCUSSION

The present study helped to evaluate HRV in different phases of menstrual cycle in healthy females of South Indian population. This study showed that though non-significant, an increase in LF nu as well as LF/HF ratio was noted in the secretory phase, whereas an increase of HF nu was noticed in the proliferative phase. This further explains an increase in sympathetic activity and a decrease in parasympathetic activity during the secretory phase than compared to the early phase of menstrual cycle. This can explain a significantly increased resting heart rate in the secretory phase compared to proliferative phase (*P* value 0.001). Increased sympathetic activity in the secretory phase could be explained due to the

Table 1: Anthropometric parameters of the study population

Parameter	Mean±Std. Deviation
Age (years)	21.16±1.21
Weight (kg)	55.64±8.12
Height (m)	1.60±0.07
BMI (Kg/m^2)	21.49±2.40
Duration of menstrual cycle	28.58±1.17

BMI: Body mass index

Table 2: Resting heart rate and blood pressure of the study population in different phases of menstrual cycle

Parameter	Proliferative	Secretory	(Paired *t*-test) *P* value
SBP (mm Hg)	104.95±6.84	108.00±7.88	0.132
DBP (mm Hg)	71.89±7.84	72.32±6.64	0.743
HR (No/min)	70.74±6.77	76.37±6.51	0.001

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HR: Heart rate

Table 3: Frequency domain HRV parameters LF nu domain, HF nu domain, and LF/HF ratio of the study population in different phases of menstrual cycle

Domain	Proliferative	Secretory	(Paired *t*-test) *P* value
LF nu	85.21±1.72	85.62±1.63	0.249
HF nu	14.67±1.91	14.14±2.06	0.262
LF/HF	5.93±0.99	6.20±0.15	0.326

HRV: Heart rate variability, HF: High frequency, LF: Low frequency, nu: normalized units

effect of progesterone, as it can cause an inhibitory effect on cardio-vagal activity of estrogen.[10-12] An increased parasympathetic activity in proliferative phase could be explained due to the action of estrogen which can enhance the vagotonic activity.[13]

The results of this study are in accordance with the previous studies done by Matsumoto and Ushiroyama,[14] Brar *et al*.,[9] and Bai *et al*.,[15] which showed an increased sympathetic and parasympathetic activity in secretory and proliferative phase, respectively. Studies done by Kavitha *et al*.,[16] Rani *et al*.[17] noted an increase in LF/HF ratio in the secretory phase compared to menstrual as well as proliferative phases of menstrual cycle. Other studies done by Yildirir *et al*.,[18] Guasti *et al*.[4] noted a significant increase of sympathetic activity in luteal phase, whereas an increased parasympathetic modulation was seen in the luteal phase as per the study done by Princi *et al*.[19] A significant correlation between the peak level of estrogen and cardiacvagal activity was observed by Leicht *et al*.,[20] which can explain the increased HF nu value in proliferative phase compared to secretory phase of menstrual cycle.

Although non-significant, an increase in systolic blood pressure was noted in the secretory phase compared to proliferative phase. This is in accordance with the study done by Tsai *et al*.,[21] which could be explained due to the variations in sex hormones that can influence the sympathetic activity in secretory phase.

This study noted an increased vagal activity in the proliferative phase and an increased sympathetic activity in the secretory phase, which could be explained by the effect of estrogen as well as progesterone, respectively, which ultimately determines the sympathovagal balance. Increased sympathetic modulation in the secretory phase can explain the symptoms of premenstrual syndrome and the knowledge of the same can improve the quality of life among females.[22] Further studies in a larger population may be needed to establish the results.

Strength of the study: A slight increase in LF nu as well as LF/HF ratio was noted in the secretory phase, whereas HF nu was slightly increased in the proliferative phase. Hence, a significant increase in resting heart rate was found in the secretory phase compared to proliferative phase. This study helped us to assess the sympathovagal balance in different phases of menstrual cycle in healthy females of normal BMI.

Limitations of the study

Estimation of hormones in both the phases of the menstrual cycle as well as more sample size would have better helped to establish the relationship between HRV and fluctuations of the sex hormones.

CONCLUSION

This study concluded that endogenous sex hormones influence the sympathovagal balance in normally menstruating females. Any hormonal imbalance may lead on to the disruption of this balance, resulting in cardiac autonomic dysfunction. Further studies should be done in a larger sample size to establish the results and to improve the clinical interpretation which may further improve the quality of life

ACKNOWLEDGMENTS

The author acknowledges the valuable help of Dr. Ajith TA, Professor, Department of Biochemistry, Amala Institute of Medical Sciences, Thrissur, Kerala, India, during the preparation of this manuscript.

REFERENCES

1. Anonymous. Heart rate variability: Standards of measurement, physiological interpretation, and clinical use: Task force of the European society of cardiology and the North American society of pacing and electrophysiology. Eur Heart J 1996;17:354-81.
2. Chatterjee S, Aditya S, Tibarewala DN. A comparative study between females of pre-pubertal and reproductive age groups to explore how HPG-axis affects the autonomic control over cardiac activity. Indian J Biomech 2009;7:233-6.
3. Fu CH, Yang CC, Lin CL, Kuo TB. Alteration of cardiovascular autonomic functions by vegetarian diets in postmenopausal women is related to LDL cholesterol levels. Chin J Physiol 2008;51:100-5.
4. Guasti L, Grimoldi P, Mainardi LT, Petrozzino MR. Autonomic function and baroreflex sensitivity during a normal ovulatory cycle in humans. Acta Cardiol 1999;54:209-13.

5. Chinagudi S, Badami S, Herur A, Patil SS, Shashikala GV, Ankad RB. Immediate effect of short duration of slow deep breathing on heart rate variability in healthy adults. Natl J Physiol Pharm Pharm 2014;4:233-5.
6. Heart rate variability: Standards of measurement, physiological interpretation and clinical use. Task force of the European society of cardiology and the North American society of pacing and electrophysiology. Circulation 1996;93:1043-65.
7. Szmigielska K, Jegier A. Zmienność rytmu zatokowego serca a wysiłek fizyczny. Med Sportiva 2004;8:17-26.
8. Vishrutha KV, Harini N, Ganaraja B, Pavanchand A, Susheela V. A study of cardiac autonomic control and pulmonary functions in different phases of menstrual cycle. Int J Appl Biol Pharm Technol 2012;3:306-11.
9. Brar TK, Singh KD, Kumar A. Effect of different phases of menstrual cycle on heart rate variability. J Clin Diagn Res 2015;9:CC01-4.
10. Carr MC. The emergence of the metabolic syndrome with menopause. J Clin Endocrinol Metab 2003;88:2404-11.
11. Shetty SB, Pai SR. Comparison of cardiac autonomic activity and BMI in different phases of menstrual cycle using heart rate variability. Int J Basic Med Sci 2011;2:100-5.
12. Tanaka M, Sato M, Umehara S, Nishikawa T. Influence of menstrual cycle on baroreflex control of heart rate: Comparison with male volunteers. Am J Physiol Regul Integr Comp Physiol 2003;285:R1091-7.
13. Sato N, Miyake S, Akatsu J, Kumashiro M. Power spectral analysis of heart rate variability in healthy young women during the normal menstrual cycle. Psychosom Med 1995;57:331-5.
14. Matsumoto T, Ushiroyama T. Altered autonomic nervous system activity as a potential etiological factor of premenstrual syndrome and premenstrual dysphoric disorder. Biopsychosoc Med 2007;1:24.
15. Bai X, Li J, Zhou L, Li X. Influence of the menstrual cycle on nonlinear properties of heart rate variability in young women. Am J Physiol Heart Circ Physiol 2009;66:765-74.
16. Kavitha C, Jamuna BL, Kumar V. Cardiac chronotropism and sympathovagal balance in young women of reproductive age. Int J Biol Med Res 2012;3:2313-18.
17. Rani YS, Manjunath P, Desai RD. Comparative study of heart rate variability, heart rate and blood pressure in different phases of menstrual cycle in healthy young women aged 18-22 years. J Physiol Pharm Adv 2013;3:188-92.
18. Yildirir A, Kabakci G, Akgul E, Tokgozoglu L, Oto A. Effects of menstrual cycle on cardiac autonomic innervation as assessed by heart rate variability. Ann Noninvasive Electrocardiol 2001;7:60-3.
19. Princi T, Parco S, Accardo A, Radillo O, De Seta F, Guaschino S. Parametric evaluation of heart rate variability during the menstrual cycle in young women. Biomed Sci Instrum 2005;41:340-5.
20. Leicht AS, Hirning DA, Allen GD. Heart rate variability and endogenous sex hormones during the menstrual cycle in young women. Exp Physiol 2003;88:441-6.
21. Tsai PS, Yucha CB, Sheffield D, Yang M. Effects of daily activities on ambulatory blood pressure during menstrual cycle in normotensive women. Appl Psychophysiol Biofeedback 2003;28:25-36.
22. De K, Chatterjee S, Patra S, Mishra J. A study of sympathetic autonomic function in different phases of menstrual cycle among young adult females. Natl J Physiol Pharm Pharmacol 2019;9:579-82.

How to cite this article: James T, Sunil N. Heart rate variability in different phases of menstrual cycle among healthy medical students of a teaching institution, South India. Natl J Physiol Pharm Pharmacol 2020;10(05):405-408.

Source of Support: Nil, **Conflicts of Interest:** None declared.