Original Research Article

Study of cyclical alteration in heart rate variability among young eumenorrheic women

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Abstract

Background: In females, rhythmic changes in the rate of secretion of ovarian hormones produce physiological changes in the brain, in the musculoskeletal system, cardiovascular and pulmonary functions, in addition to changes in the reproductive system, which are evident during menstrual cycle. Present study was aimed to evaluate cyclical alteration in heart rate variability among young eumenorrheic women. **Material and Methods:** Present study was an observational cross-sectional study conducted in female students aged between 18-25 years, with regular menstrual cycles for past few months. Each subject was examined on three separate occasions of the menstrual cycle, on second day (menstrual phase), tenth day (proliferative phase) and twenty first day (secretory phase) for various heart rate variability parameters. **Results:** Among various HRV parameters, SDNN was comparable among all three groups. We noted a significant difference among Mean RR, Mean HR, RMSSD, NN50 and pNN50, that to between proliferative phase and secretory phase. Various parameters were in proliferative phase were suggestive of increased vagal activity while parameters during secretory phase were suggestive of increased sympathetic activity. **Conclusion:** Proliferative phase of menstrual cycle was characterized by increased vagal activity and the secretory phase of menstrual cycle was characterized by increased sympathetic activity.
Keywords: heart rate variability, menstrual cycle, proliferative phase, secretory phase

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INTRODUCTION

In females, rhythmic changes in the rate of secretion of ovarian hormones produce physiological changes in the brain, in the musculoskeletal system, cardiovascular and pulmonary functions, in addition to changes in the reproductive system, which are evident during menstrual cycle.[1] Exaggerated response to hormonal changes may be responsible for different physical and psychological ramifications occurring during menstrual cycle though other factors may also be involved.[2] Heart rate variability (HRV) is a reliable reflection of the many physiological factors modulating the normal rhythm of the heart. Heart rate variability (HRV) is a non-invasive electrocardiographic marker, reflecting the effects of the autonomic system on the sinus node of the heart.[3] For a better understanding of the cardio-vagal activity in healthy Indian females, to improve the quality of life, study of heart rate variability during various phases of menstrual cycle is required. Present study was aimed to evaluate cyclical alteration in heart rate variability among young eumenorrheic women.

MATERIAL AND METHODS

Present study was an observational cross-sectional study conducted under Department of Physiology, at Belagavi, India. This study was commenced after getting ethical approval from the Institutional Ethics Committee.

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Inclusion criteria: female students aged between 18-25 years, with regular menstrual cycles for past few months.

Exclusion criteria: Pregnant Females, Females with irregular menstrual cycles, menorrhagia, Females with any endocrine disorder, on any medication during the study (including oral contraceptive pills), Not willing to participate, follow-up.

The written informed consent was taken from each subject. 50 female students aged between 18-25 years, with regular menstrual cycles for past few months were studied. Demographic details, thorough menstrual history was taken including nature and days of menstrual flow, regularity and total duration of cycle. Anthropometric measurements such as height and weight were assessed and Body mass index was calculated. Each subject was examined on three separate occasions of the menstrual cycle, on second day (menstrual phase), tenth day (proliferative phase) and twenty first day (secretory phase). All the procedures were done in the morning period, after 2 h of their light breakfast. The examination was carried out at 10 am -12 noon to avoid diurnal variation.

ECG electrodes were placed on RA (right arm), LA (left arm), LL (left leg), and RL (right leg). After recording ECG clicked at transform button and selected HRV. Filled the required time to achieve the HRV data for that particular time. HRV was measured using analog electrocardiogram amplifier with analog to digital conversion using the sound card.

The frequency domain shows the variability of the RR signal overtime by looking at the proportion of the frequencies relative to the original RR signal. Other parameters were RMSSD (the square root of the mean of the squares of the successive differences between adjacent NNs.), NN50 (the number of pairs of successive NNs that differ by more than 50 ms), pNN50 (the proportion of NN50 divided by total number of NNs). The data was analysed statistically. Student's paired t-test was used for the analysis. $p<0.05$ was considered to be statistically significant.

RESULTS

In present study demographic and anthropometric characteristics of study subjects was mean age as 22.1 ± 3.01 years, mean height 155.68 ± 6.41 cms, mean weight 55.83 ± 8.13 kgs, mean BMI was 22.03 ± 2.02 kg/m^2.

Table 1: Demographic characteristics

Demographic characteristics	Mean±SD
Age (years)	22.1 ± 3.01
Height (cms)	155.68 ± 6.41
Weight (kg)	55.83 ± 8.13
BMI (kg/m2)	22.03 ± 2.02

Among various HRV parameters, SDNN was comparable among all three groups. We noted a significant difference among Mean RR, Mean HR, RMSSD, NN50 and pNN50, that to between proliferative phase and secretory phase. Various parameters were in proliferative phase were suggestive of increased vagal activity while parameters during secretory phase were suggestive of increased sympathetic activity.

Table 2: Analysis of HRV parameters

HRV parameters	Menstrual phase	Proliferative phase	Secretory phase	P value
Mean RR	0.85 ± 0.09	0.21 ± 0.11	0.58 ± 0.09	<0.001
SDNN	0.04 ± 0.02	0.05 ± 0.02	0.04 ± 0.02	0.072
Mean HR	81.08 ± 9.14	72.91 ± 8.63	79.08 ± 8.82	<0.001
RMSSD	29.10 ± 20.38	33.21 ± 20.91	22.78 ± 19.73	0.035
NN50	8.45 ± 5.87	10.92 ± 6.92	7.48 ± 4.27	0.022
pNN50	7.27 ± 5.1	8.34 ± 7.13	5.98 ± 3.96	0.021

DISCUSSION

Natural fluctuations in ovarian hormones across the menstrual cycle allow for noninvasive studies of the effects of endogenous hormone (estrogen, progesterone, luteinizing hormone and follicle stimulating hormone) on cognition impairment and heart rate variability in young females. Heart rate variability (HRV) refers to the variations in the beat intervals or correspondingly in the instantaneous HR. The normal variability in HR is due to autonomic neural regulation of the heart and the circulatory system. In addition to the influences of genes, many environmental and behavioral factors like exercise, smoking, consumption of certain beverages some biological factors, such as body build and obesity, affect HRV.[4] Priyadharshini UK *et al.*,[5] noted that sympathetic parameters like (low frequency domain) LF nu, LF/HF ratio was significantly increased in the premenstrual phase. The parasympathetic parameters like (high frequency domain) HF nu, TP (total power) were significantly increased in the proliferative phase of the menstrual cycle. The cardioprotective role of female sex hormones in premenopausal women was more pronounced in the proliferative phase of menstrual cycle.[5] James T *et al.*,[6] 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). 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. In study by Tejinder Kaur Brar *et al.*,[7] concluded that sympathetic nervous activity in secretory phase is greater than in the proliferative phase, whereas parasympathetic nervous activity is predominant in proliferative phase. Similar findings were noted in present study. Pullaganti M *et al.*,[8] studied the effect of stress and autonomic balance in different menstrual cycle phases of 50 young adolescent female students aged between 18-25 years. All parameters were measured in premenstrual phase (25th ± 4 days) and postmenstrual phase (10th ± 5 days). Low frequency (LF) increases from 0.07 ± 0.009Hz to 0.08 ± 0.005 Hz (P – 0.01). However, high frequency decreases from 0.27 ± 0.02Hz to 0.26 ± 0.01Hz (P - 0.01). The time domain parameters SDNN 59.11 ± 24.1 increase to 74.34 ± 52.7 (P – 0.04). STD HR significantly reduced from 69.58 ± 12.1 to 35.36 ± 16.4 (P - 0.01). RMSSD increased from 47.98 ± 5.5 to 75.24 ± 14.6 (P – 0.02), NN50 reduced from 64.65 ± 12.8 to 48.52 ± 12.4 statistically significant (P – 0.05). However, there is no significant change in cortisol levels in both phases. Conclusion: The results suggest that there is a significant difference in sympathovagal balance between pre- and post-menstrual phases. LF indicates that vagal discharge is more in premenstrual phase, whereas sympathetic tone increases in postmenstrual phase. In study by Rani Y S U[9], 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. Sympathetic nervous activity in the luteal phase is greater than in the follicular phase, whereas parasympathetic nervous activity is predominant in the follicular phase.[9] Heart rate may also be higher in secretory phase due to higher levels of progesterone in that phase, which has thermogenic action.[10] The present study limitations were determination of phases of menstrual cycle on history and no definitive conclusions about the effects of hormonal regulation within these menstrual phases on heart rate variability. Further studies are recommended with inclusion of hormonal as well ultrasonography estimations at various phases of menstrual cycle.

CONCLUSION

In present study parameters such as RMSSD, NN50 and pNN50, estimated high frequency variations in heart rate. Proliferative phase of menstrual cycle was characterized by increased vagal activity and the secretory phase of menstrual cycle was characterized by increased sympathetic activity.

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