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Influence of regular exercise on cardiac autonomic activity in. healthy young women during the normal menstrual cycle

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ABSTRACT

Regular physical exercise leads to considerable changes demonstrated in the increase of health related fitness. Heart rate variability is a measure of autonomic nervous system function. Gonadotropin hormones affect autonomic nervous system function. Regular exercise is thought to modulate the sympathovagal control of the heart leading to an enhancement of the vegetative control of the heart. The present study aims to describe the heart rate variability and assesses its association with regular exercise and menstrual cycle in healthy young women in frequency domain method in different phases of menstrual cycle. A total of 54 female students were selected. The selected students were divided into two groups namely Group I consisted of subjects doing regular physical exercise for 30 minute each day and Group II consisted of individuals who were non exercisers the ECG recording were taken during the 3 phases of menstrual cycle. The analog ECG signal were conveyed through an A/D converter to PC and were analyzed .The frequency domain analysis was done in which the LF, HF and LF/HF components were studied. Results showed that a significant increase in the LF/HF ratio in the luteal phase of menstrual cycle in the non exercisers group when compared to other phases of the menstrual cycle ($P<0.001$) . Regular exercisers had more parasympathetic activity than non exercisers. Detection of sympatho vagal inbalance at an early age based on regular exercising with necessary life style modification could decrease the incidence of cardiovascular diseases as age advances.

Keywords: Exercise, cardiac autonomic activity, menstrual cycle

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INTRODUCTION

Regular physical exercise leads to considerable changes demonstrated in the increase of health related fitness and in the decrease of the risk factors leading to a number of disabling medical conditions which occur in people who are inactive [1]. The menstrual cycle has a cyclical nature that lasts approximately 28 days, and has been identified as a major factor in changes in female physiology [2]. Changes in hormone concentrations secreted by the hypothalamus-pituitary-gonadal axis, particularly estrogen and progesterone, determine the three phases of menstrual cycle [2]. The influence of the different phases of the menstrual cycle has been studied on factors such as the risk of injury, flexibility, anaerobic power, muscle strength, sports performance, and cardiovascular mechanisms [3-5]. Available literature shows that HRV (Heart rate variability) is influenced by levels of the physical activity [6]. The HR control and response follows a well-defined pattern both at rest and during exercise [6]. This autonomic control is an important indicator of health, because adults with autonomic dysfunction have higher all-cause and cardiovascular mortality rates [7,8].

Available literature shows that the HRV is affected by the menstrual cycle [9-11]. Several studies have found variation of symphatho-vagal activities during the menstrual cycle. Previous studies have indicated that parasympathetic activity is lower during the luteal phase compared with other phases of the menstrual cycle in healthy women [12]. Power spectral analysis of heart rate variability has been used as a sensitive index of autonomic nervous activities[12,13,14]. Our previous study on Comparsion of time and frequency domain analysis of heart rate variability in different phases of menstrual cycle showed LF/HF ratio higher in the luteal phase compared to the follicular phase and the LF/HF ratio is greater in the follicular phase compared to the menstrual phase [15].Sympathetic activity is significantly higher in the luteal phase than in the follicular phase. However, others have reported the menstrual cycle were not significantly associated with changes in autonomic nervous activity [16]. Previous studies on evaluation of HRV on BMI, neurocardiac parameters during the various phases of menstrual cycle would be useful and highly relevant for cardiovascular evaluation of women at higher risk to develop heart disease, thus permitting early intervention [17].

Athletes have lower resting heart rate (HR) compared with sedentary people. This bradycardia leads to longer average RR interval length in athletes because of the enhanced diastole[18]. A lower resting heart rate can be induced by higher vagal activity and/or diminished sympathetic activity. Thus, exercise training is thought to modulate the sympathovagal control of the heart resulting in a predominance of the vagal activity by an increased vagal and/or a decrease sympathetic nervous activity [19]. This modulation is supposed to lead to an enhancement of the vegetative control of the heart which has been quantified by an increased HRV. Several studies suggest that, there are definite changes in the HRV in the different phases of the menstrual cycle but studies are lagging correlating the cardiac autonomic activity, menstrual cycle and regular exercisers in young females . The present study aims to describe the HRV and assesses its association with regular exercise and

menstrual cycle in healthy young women in frequency domain method in different phases of menstrual cycle.

MATERIALS AND METHODS

A total of 40 female students studying their MBBS Course in Kasturba Medical College Bejai, Mangalore were selected . The selected students were in the age group 18-25 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.

Experimental protocol[15, 17]:

The selected students were divided into two groups namely Group I consisted of subjects doing regular physical exercise for 30 minute each day and Group II consisted of individuals who were non exercisers . The ECG recording were taken during the following 3 phases Menstrual phase (M) – 1st to 5th day of bleeding ,

Follicular phase (F) - 6th day to 14th day of menstrual cycle.
Luteal phase (L) - 15th day to 28th day or the next menstrual bleeding.

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 recordings of ECG of all subjects were done by the same person of our team in order to avoid any inter–observer error. 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. ECG signals were conveyed through an A/D converter to PC and were analysed offline after visual checking of abnormal ECG. Heart rate variation during normal breathing for a period of 5 minutes was recorded, with subject supine, awake and resting. In the present study one of the variables of the time domain analysis SDNN (standard deviation of all the N-N intervals) 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) was measured. We have also evaluated and analyzed the ratio LF/HF [20-22].

Statistical analysis

The statistical analysis was done using ANOVA (Analysis of variance), student's unpaired T test, Mannwhitney U test, Tukey's Test. P value was taken as significant at 5 percent confidence level ($p < 0.05$)

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Table 1: Effect of variation in HRV in the three different phases of menstrual cycle in regular exercisers (Group I) and non exercisers (Group II) (n=20; n is the total number of subjects). Values expressed as Mean±SD.

PHASES OF MENSTRUAL CYCLE	GROUPI (Exercisers)			Group II (Non Exercisers)		
FOLLICULAR	LF	HF	LF/HF	LF	HF	LF/HF
	46.47 ±22.35	53.52 ± 22.36	1.11±0.8	47.18 ± 17.07	52.81 ± 17.07	1.08 ± 0.64
LUTEAL	57.84± 16.02	42.15 ± 16.02	1.66 ±1.03	64.10± 16.7	37.47 ± 14.42	2.01 ±1.09**
MENSTRUAL	38.77 ± 16.82	61.22 ± 16. 82	0.74±0.52	42.05 ± 20.51	61.17 ± 15.04	0.78 ± 0.71

P< 0.001** - Group I versus Group II

RESULTS

In the present study, the variations of LF, HF, and LF/HF ratio in group I showed no statistically significant difference in between the three phases of menstrual cycle. Further in group II there was a significant increase in the LF/HF ratio in the luteal phase of menstrual cycle when compared to other phases of the menstrual cycle (P<0.001).

DISCUSSION

Autonomic regulation of the heart in the normal woman differs during the menstrual cycle[23]. Cardiac autonomic functions can be influenced by multiple factors. The results of the present study support that regular physical exercise play an important role in the woman's cardiac autonomic modulation[24]. Our results clearly demonstrated a significant difference in the autonomic nervous activity in the luteal phase of the menstrual cycle in young females with no regular physical exercise. The LF power reflects modulation of sympathetic tone with contribution from the parasympathetic tone (PS), while HF power reflects the modulation of parasympathetic tone alone. Exercise produces a reduction in resting heart rate, probably due to an increase in parasympathetic tone which might account for the benefit of exercise in reducing all cause and cardiovascular mortality.

Luteal phase of MC was associated with a significant increase in the LF component and a significant decrease in the HF component, resulting in a high LF/HF ratio. Our findings were in agreement with earlier work who observed that sympathetic nervous activities are predominant in the luteal phase as compared with follicular phase[24, 25]. In this study exercise was a major determinant of cardiac autonomic nervous modulation. Woman between 16-25 years with regular exercise had more parasympathetic activity than non exercisers. In women with less physical activity cardiac autonomic activity had a predominant sympathetic profile. LF/HF ratio is the most sensitive indicator of sympathovagal balance[26] In the present study , non exercisers group showed a higher increase in the LF/HF ratio in the luteal phase of the menstrual cycle, this indicated presence of sympathovagal imbalance (SVI).

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CONCLUSION

In conclusion, this study has shown that women with no regular physical exercise had significant changes in autonomic nerve function that included reduced parasympathetic control and elevated sympathovagal modulation. It is well established that lower heart rate variability is associated with increased cardiovascular morbidity. Detection of sympatho vagal imbalance at an early age based on regular exercising and necessary life style modification could decrease the incidence of cardiovascular diseases as age advances.

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