ORIGINAL ARTICLE

HEART RATE CHANGES DURING DIFFERENT PHASES OF MENSTRUAL CYCLE

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Background: Menstruation is only one manifestation of the ovarian cycle which is itself associated with many physical, psychological and behavioural changes. Autonomic changes occur during different phases of the menstrual cycle. The aim of the research work was to study heart rate changes during different phases of normal menstrual cycle using group of tests and to establish the validity of such conflicting results. **Methods**: Heart rate changes were evaluated in 30 female students of J.S.S. Medical and Dental College and Hospital, Mysore, India aged between 18–25 years during different phases of menstrual cycle. Students with normal menstrual cycle were chosen for the study. These tests were conducted on specified days of menstrual cycle in the morning during 3 phases of menstrual-menstrual, follicular and luteal. Heart rate change tests were performed at Rest, Expiration-Inspiration ratio, 30:15 ratio, S/L ratio and Valsalva ratio. These batteries of tests were shown to be reliable and reproducible with very little physical or mental efforts by the subject. **Results**: The resting heart rate difference between menstrual and luteal, and between follicular and luteal was not statistically significant (p>0.05). There was no statistically significant difference of 30:15 ratio, E-I ratio, S/L ratio, and valsalva ratio between the 3 phases of menstrual cycle. (p>0.05). **Conclusion**: It may be concluded that there was no heart rate changes during different phases of menstrual cycle within our study group. In spite of being non-invasive technique, the present study would be clinically useful.

Keywords: Autonomic functions, Electrocardiograph, Heart rate, Menstrual cycle

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INTRODUCTION

The menstrual cycle is much more than a cycle of periods. Menstruation is only one manifestation of the ovarian cycle which is itself associated with many physical, psychological and behavioural changes. Numerous clinical disorders also appear to be modulated by cyclical ovarian activity. Objective assessment of these cyclical changes can be difficult.

The menstrual cycle in women is related to ovulation and the secretion of ovarian hormones. Between the menarche and the menopause the endometrium undergoes cyclical changes which are initiated in the hypothalamus and mediated by the pituitary gandotrophins namely FSH & LH which act on ovary to induce release of oestradiol and progesterone. Menstrual cycle is the periodic vaginal bleeding that occurs with the shielding of the uterine mucosa. Menstrual is a Latin word which means 'mensis' a month, i.e., a lunar month of 28 days. However, the cycle is by no means as regular as the word suggests and menstrual cycles of 25 to 35 days are regarded as normal cycles.

The literature reveals all types of behavioural and other changes in women especially during the premenstrual phase. Certain autonomic changes have also been reported during different phases of menstrual cycle, though more so during the premenstrual phase.[1] Changes in the autonomic functions during different phases of the normal menstrual cycle are not well documented and available reports are conflicting.[2]

Although autonomic function tests are criticized on the grounds that they do not give direct measure of autonomic activity. Results correlated well with over all dysfunction of autonomic nervous system and have been found to be helpful in determining the progress. It has been recommended that group of tests rather than a single test is better in detecting autonomic involvements.

Autonomic changes occur during different phases of the menstrual cycle. Considerable lacunae exist regarding exact knowledge of different phases of menstrual cycle affecting autonomic functions. Very few studies have been reported and results are conflicting.[3–5] The aim of this study was to see heart rate changes during different phases of normal menstrual cycle and to establish the validity of such conflicting results.

SUBJECTS AND METHODS

The study was performed in the Department of Physiology, JSS Medical College and Hospital, Mysore, India in accordance with the ethical standards of the JSS Medical College's Institute Human Ethics Committee conformed to the standards set by the latest revision of the Declaration of Helsinki and that the procedures were approved by JSS Medical College's Human Ethics Committee.

Thirty lady medical students of JSS Medical College & Hospital, and JSS College & Hospital

Mysore, India aged 18–25 years were selected for the study. Informed consent in writing was obtained from each subject. Those students having regular menstrual cycle lasting 26–34 days and normal range of haematological and biochemical parameters within normal limits and normotensive were included. Duration of previous 3 menstrual cycle were noted based on subjects' statements. A full clinical history and complete physical examination was made on each subject. The subjects with menorrhagia, irregular menstrual cycle, history of diabetes mellitus, hypertension, endocrine disorders, history of postural symptoms or syncopal attacks, and history of medication during the study were excluded.

Heart rate changes were recorded on specified days of the menstrual cycle in the morning in 3 phases of menstrual cycle, i.e., menstrual phase (Group-I), follicular phase (Group-II), and luteal phase (Group-III).

The stage of the cycle on entry was calculated from the date of onset of the previous menstrual period. Each student was studied for 8 weeks so that at least two full menstrual cycles were completed. The different autonomic functions tested were heart rate changes viz., resting heart rate, E-I difference, 30:15 ratio, S/L ratio, and valsalva ratio.

Electrocardiogram (ECG) was recorded in Lead II run for one full minute. The heart rate was calculated as following:

$$\textbf{Heart rate/minute} = \frac{\textbf{1500}}{\textbf{R-R interval (mm)}}$$

The subject was instructed to breathe deeply for one minute at the rate of 6 breaths/minute in semi recumbent posture. From the ECG recording, maximum and minimum R-R intervals were measured. From this maximum and minimum R-R during each breath were converted to beats/minute. The difference between maximum heart rate during inspiration and minimum heart rate during expiration were determined and expressed as maximum- minimum difference.

ECG was recorded continuously in three different positions, viz., lying position (about 30 beats), while standing and after standing for about 60 beats. From this heart rate variation, 30:15 ratio was calculated which is the ratio of the longest R-R interval at around 30th beat divided by the shortest R-R interval at around 15th beat after standing.

S/L ratio was calculated by taking longest R-R interval during 5 beats before lying down (while standing)/shortest R-R interval during 10 beats after lying down.

Valsalva manoeuvre consisted of forceful continued expiratory effort against the closed glottis with the subject either sitting or supine. Expiratory pressure was maintained at 40 mm/Hg (by blowing through the sphygmomanometer tube) and retained at that level for 15 seconds. ECG was recorded continuously before, during, and after the strain for 60 beats. Valsalva ratio was calculated as the longest R-R interval during manoeuvre.

Pooled *t*-test was applied for comparing 2 groups and $p<0.05$ was taken statistically significant. Microsoft Excel was used for data processing.

RESULTS

Mean values, and standard deviation for resting heart rate variability, E-I ratio, 30:15 ratio, S/L ratio, and Valsalva ratio for 30 subjects during different phases of menstrual cycle are given in Table-1.

Table-1: Autonomic function tests measured on electrocardiogram during different phases of menstrual cycle

Study Parameters	Menstrual phase (Group I) Mean±SD	Follicular Phase (Group II) Mean±SD	Luteal Phase (Group III) Mean±SD	*p*-value between Group I & II	*p*-value between Group II & III	*p*-value between Group I & III
Resting Heart rate	77.6±8.53	76.77±10.14	80.9±9.79	>0.05 (NS)	>0.05 (NS)	>0.05 (NS)
E-I Ratio	1.43±0.17	1.43±0.13	1.45±0.14	>0.05 (NS)	>0.05 (NS)	>0.05 (NS)
30:15 Ratio	1.20±0.09	1.18±0.09	1.17±0.10	>0.05 (NS)	>0.05 (NS)	>0.05 (NS)
S/L Ratio	1.30±0.16	1.30±0.16	1.32±0.11	>0.05 (NS)	>0.05 (NS)	>0.05 (NS)
Valsalva Ratio	1.28±0.06	1.29±0.08	1.28±0.07	>0.05 (NS)	>0.05 (NS)	>0.05 (NS)

Values are mean ± SD. * n= 30, S= Significant NS= Not significant

DISCUSSION

The menstrual cycle is characterized by different phases with different endogenous hormones and consequently by different neurotransmitter concentrations. The cyclic changes in estradiol and progesterone levels modulate physiological functions. However the relation between the menstrual cycle and vegetative control of the heart remains disputable due to the lack of studies.

The resting heart rate difference between menstrual phase (Group-I) and follicular phase (Group-II), Group-I and luteal phase (Group-III) and Group-II and Group-III was not statistically significant ($p>0.05$).

The results are consistent with each of the previous studies.[6–9] Behavioural and psychological changes were reported during the premenstrual phases.[10]

It has long been known that women become irritable, tense or depress in the premenstrual week. It is possible that higher sympathetic activity and higher resting levels of circulating plasma norepinephrine in the luteal phase is responsible for increased heart rate.

The present study has not shown statistically significant E-I ratio between the 3 phases of menstrual cycle. This test is simple and clearly discriminate patients with and without vagal neuropathy of heart than measurements made during quiet breathing. Normally during maximal breathing, the R-R changes in the ECG will show increase in the heart rate during inspiration and decrease during expiration. It would be assumed that loss of R-R variation is most probably due to vagal autonomic neuropathy.

Several physiologic mechanisms contribute to sinus arrhythmia. These include both reflex mechanisms, pulmonary stretch receptors, baroreceptors, brain bridge reflex, and a direct interaction of respiration with cardiovascular medullary centres. Parasympathetic efferents are responsible for mediating this effect.

Patients with heart disease have lowered respiratory heart variations than the normal, diminished variations in heart rate associated with increased risk of cardiac arrhythmias. Since respiratory sinus arrhythmia is predominantly mediated by vagus nerve hypothesis is that the degree of respiratory sinus arrhythmia may be used as a non-invasive quantitative measure of the degree of parasympathetic heart rate control. This hypothesis is tested by a) combining the implications of published models of heart rate control with observation of cardiac vagal efferent activity during respiratory sinus arrhythmia and b) performing animal experiments in which the vagus repeatedly and reversibly blocked.

Similarly, there was no significant difference between any groups for 30:15 ratio, S/L ratio and Valsalva ratio (p>0.05). These results are consistent with an earlier study[11].

The 30:15 ratio is biphasic response mediated by the afferent inputs from muscle, vagus nerve and the baroreceptor reflex arc. Heart rate response to standing in normal subject characterized by immediate shortening of R-R interval which is maximal around 15th beat after standing followed by relative lengthening of R-R interval around 30th beat after standing. This immediate difference in heart rate on standing could be due to withdrawal of vagal tone.

There was no significant difference of S/L ratio between the 3 phases of menstrual cycle, which is consistent with an earlier study[11]. S/L ratio reflects the ratio of sympathetic and parasympathetic activity. In standing position sympathetic activity is dominant due to vagal withdrawal which causes increase in heart rate. In supine position tonic vagal discharge is more which causes decrease in heart rate.

The valsalva ratio is calculated from heart rate changes during the manoeuvre and defined as the maximum phase II tachycardia divided by the minimum phase IV bradycardia and may be expressed as a ratio of the largest R-R interval on ECG during Phase IV to the shortest R-R interval of Phase II. The valsalva manoeuvre tests both sympathetic and parasympathetic divisions of nervous system, which sympathetic dysfunction tachycardia in phase 2 and blood pressure increases at start of phase IV are attenuated. The fall in blood pressure occurring during phase II may not be terminated by vasoconstriction with parasympathetic nervous system dysfunction, the baroreceptors mediated by reflex bradycardiac response to the elevated blood pressure in phase IV, does not occur. Higher valsava ratio was observed in the luteal phase compared to the follicular phase[12]. However there was no statistically significant difference in the valsalva ratio between different phases of menstrual cycle in the present study.

CONCLUSION

The non-invasive recordings provide a quantitative evaluation of sympatho vagal interaction modulating the cardiovascular function. There were no statistically significant differences in heart rate during three phases of menstrual cycle.

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