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RESEARCH ARTICLE

Comparison of perceived stress and cardiovascular reactivity during different phases of menstrual cycle

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ABSTRACT

Background: Premenstrual syndrome is associated with many physical, psychological, and behavioral changes. Premenstrual symptoms have been associated with perceived stress and perceived stress is the strongest predictor of premenstrual syndrome. **Aim and Objective:** The purpose of this study was to investigate the premenstrual stress and cardiovascular reactivity during different phases of menstrual cycle in the age group of 18–22 years. **Materials and Methods:** In this study, 60 healthy female volunteers of the age group of 18–22 years selected. The resting blood pressure (BP) and perceived stress with the help of Cohen's perceived stress scale were recorded. The cardiovascular reactivity during different phases of menstrual cycle was recorded with the help of cold pressor test and postural challenge test. **Results:** The study revealed that significant increase was observed in perceived stress, pulse rate, and resting BP, during premenstrual period as compared to postmenstrual period. BP also showed significant increase during cold pressor tests and postural challenge test during premenstrual period as compared to postmenstrual period. **Conclusions:** According to this study, perceived stress and cardiovascular reactivity are highest during premenstrual phase as compared to postmenstrual phase. It may be due to the increased level of progesterone and estrogen in premenstrual phase. It is not clear how stress may contribute to increased premenstrual symptom severity, although stress-induced changes in ovarian hormone levels and neurotransmitters may be involved. This correlates to the symptoms of premenstrual syndrome which has hormonal and neural basis.

KEY WORDS: Perceived Stress; Cold Pressor Test; Postural Change Test; Premenstrual and Postmenstrual Phase

INTRODUCTION

Premenstrual stress is characterized by physical, psychological, and behavioral changes and is believed to affect 75% of women of childbearing age.[1] Premenstrual syndrome is a psychophysiological stress-induced disorder that some women usually experience on regular basis in relation to menstruation. Various symptoms occur generally every monthly within 7–14 days before menstruation. These symptoms mainly worsen as menstruation approaches and then subside at the onset or after several days of menstruation.

Premenstrual symptoms are the cyclical changes that a woman perceives as troublesome or problematic which escalate before menstruation, symptoms such as headache, malaise, nervous irritability, emotional instability, decrease in the ability to concentrate, and resulting in impaired motor coordination are reported during premenstrual phase suggesting heterogeneous diagnostic criteria and ethnic variation.[2-4]

In general, more stressful life events have been related to premenstrual symptoms.[5] Stress viewed as chronic

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phenomena have been found to contribute a significant amount of variance in premenstrual symptoms and higher variance in general health scores.[6]

Premenstrual symptoms have been associated with perceived stress and perceived stress is the strongest predictor of premenstrual syndrome.[7] In this study, we assessed stress using perceived stress score (PSS scale).[8]

Perceived stress is one of the primary factors associated with premenstrual syndrome, ahead of physical activity and dietary patterns.[9] Since menstrual cycle is associated with varying levels of sex steroids, it was hypothesized that blood pressure (BP), pulse rate could be altered across normal menstrual cycle.

The menstrual cycle is a natural repetitive phenomenon occurring throughout the reproductive life of every woman. The biological rhythmicity of the cycle is created by the interplay among hypothalamic, hypophyseal, and ovarian hormones. It is characterized by rhythmic variation in the secretion of female hormones and corresponds to changes in the reproductive organs and other physiological responses. Cyclic fluctuations in the plasma level of estrogen and progesterone contribute to the expression of the menstrual cycle. The menstruation mainly occurs due to sudden drop in estrogen and progesterone levels. This steroid affects the cardiovascular parameters.[10] Moreover, cardiovascular system is under the control of autonomic nervous system (ANS).

Saleh and Connell have shown that estrogens act centrally to modulate the ANS, increasing vagal and decreasing sympathetic activity,[11] thus providing a cardiovascular protective function. Progesterone, on the other hand, appears to have an opposing effect, elevating central noradrenaline release.[12] As cardiovascular system is under the control of ANS, it is easy to study the cardiovascular reactivity. Autonomic function test is non-invasive tests which mainly used to know the cardiovascular changes during different phases of menstrual cycle. Female reproductive steroids are mainly affecting the hypothalamic–pituitary–adrenal axis, which in association with ANS forms the stress system which regulates homeostatic mechanism of the body.[13] Therefore, the purpose of this study was to assess the premenstrual stress and cardiovascular reactivity during different phases of menstrual cycle.

MATERIALS AND METHODS

The study was carried out after the approval from the ethics committee in 60 healthy female volunteers in the age group of 18–22 years. Detailed history such as age of menarche, duration of menstrual cycle, and flow of each cycle was noted. The study method was non-invasive and approval was taken from the institutional ethics committee.

Inclusion Criteria

- Girls with a history of regular menstrual cycle 28–30 days duration for at least past 6 months were selected
- The study included one baseline clinic visit and 4 cycle visits (2 per cycle) over two menstrual cycles, scheduled to visit any days between 1 and 7 days before the onset of next menstruation (premenstrual phase) and 5^{th}–10^{th} days of menstrual cycle (postmenstrual phase).

Exclusion Criteria

The following criteria were excluded from the study:
- Subjects with irregular cycle
- History of oral contraceptive
- Subjects on exogenous hormones
- History of cigarette smoking and alcohol consumption.

Equipment

- Mercury sphygmomanometer
- Cohen's PSS
- Steel water tub (30 × 15 × 16 cm), separator (29 × 14 × 9 cm) S water reservoir
- (6 L capacity), and ice and thermometer were used for cold pressure test.

Parameters Measured

In the study, the following parameters measured during premenstrual and postmenstrual phases:
- Pulse rate (per min)
- BP (mmHg)
- Perceived stress using Cohen's PSS.

PSS questionnaire

The PSS is a 10-question version of the PSS-10. It is valid, reliable, and widely used psychological and psychiatric tool that measures a person's perception of stress during the previous month.

In the present study, the students were explained about the PSS scale questionnaire in detail and were told to tick the appropriate numbers. Later, the total score was assessed.

The maximum score of the scale is 40 and higher scores reflect higher levels of stress and a greater likelihood that stress interferes with the participant's health. Participants' stress levels will be classified into following three categories: Low stress (PSS score <12), average stress (PSS score 12–15), and high stress (PSS score>15).

The following tests were performed for the assessment of cardiovascular reactivity:

Resting BP

BP was recorded standard sphygmomanometer by auscultatory method. Before recording the BP, all the participants were allowed to rest for 5 min in a quiet room to reduce the anxiety.

BP from supine to standing position (Postural challenge test)

The subject was asked to lie down quietly for 10 min and then the subject is asked to stand quietly, unaided within 5 s and remain standing quietly for 1 min; the systolic and diastolic BP were measured within 1 min.

Cold pressure test

After recording of resting BP, subject was asked to sit comfortably and immerse the hand in ice cold (4–6°C) up to wrist joint for 1 min. After 1 min, subject was allowed to remove the hand. At the time of end of the test, BP was measured on the other arm of the subject. Maximum increases in both the BPs were measured.

Statistical Analysis

Data were expressed as mean ± standard deviation. Statistical analysis was obtained using ANOVA and paired *t*-test techniques. Statistical significance was taken as $P < 0.05$.

RESULTS

The findings of the present study are presented in Tables 1 and 2.

DISCUSSION

In the present study, premenstrual phase showed a significant increase in perceived stress, pulse rate, resting systolic and diastolic BP, and also increase in BP in response to posture challenge test and cold pressor test as compared to postmenstrual phase. Due to this increased stress in premenstrual phase, severity of symptoms increased. It is not clear how stress may contribute to increased premenstrual symptom severity, although stress-induced changes in ovarian hormone levels and neurotransmitters may be involved.

Stress mainly affects the hypothalamus ovarian axis which leads to various hormonal changes, causing alterations in ovarian hormones that may render a woman more susceptible to various menstrual disorders. According to Tamki, women with greater degree of premenstrual distress possess higher sympathetic activity in late luteal phase than women with fewer symptoms.[14]

Table 1: Comparison of perceived stress during different phases of the menstrual cycle

Parameter	Mean rank	*P* value
Stress 2-Stress 1		
Negative rank	30.50	0.000**
Positive rank	0.00	

**P<0.001: Highly significant

Hastrup and Light[15-17] also reported the significant rise of pulse rate and systolic and diastolic BP in premenstrual phase.

In this study, a significant increase in the resting systolic and diastolic BP was observed in the premenstrual phase as compared to postmenstrual phase. This is mainly due to progesterone effect which may increase cardiac excitability by opposing effects of estrogen.[18] Progesterone also has an inhibitory effect on the cardiovagal baroreflex responses.[19] Studies show that premenopausal women are safe from coronary heart disease as compared with age-matched men. However, this protective phenomenon disappears after menopause. This suggests that female sex hormones such as estrogen and progesterone on the cardiovascular system have some beneficial effects. Estrogens also are known to prevent the occurrence of atherosclerosis by beneficial effects on the intact endothelium, but once the vascular endothelium is injured; the prothrombotic and proinflammatory effects of estrogens may predominate.[20]

Our study showed that the systolic and diastolic BP response to postural challenge test was significantly higher in the premenstrual phase as compared to postmenstrual phases and the difference was statistically significant ($P < 0.05$). This is mainly due to sudden change of posture from supine to standing; there is venous pooling of blood in the dependent parts of the body; this ultimately decreases the venous return and cardiac output so the systolic BP decreases. This through the baroreflex mechanism, which operates within seconds, stabilizes the BP.[21] This baroreflex control of the sympathetic component increases in the premenstrual phase. Thus, it was concluded that baroreflex regulation of autonomic functions is modified by postural change during the menstrual cycle.[22]

Our study showed that the systolic and diastolic BP response to cold pressor test was statistically significantly higher in the premenstrual phase as compared to the postmenstrual phase.

Pressor test is a valuable tool to investigate sympathetic and parasympathetic function of the ANS. The cold pressor test which is considered to be a sympathoexcitatory maneuver is a simple, non-invasive, and validated test of sympathetic activation. The heart rate and BP responses to cold pressor test could be used as indicators of global sympathetic activation, and thus, of cardiac status.

The cold pressor test causes stimulation of pain receptors in the hand that reflexly increase in sympathetic outflow.

Table 2: Comparison of cardiovascular reactivity (resting blood pressure, cold pressor test, and postural challenge test) during different phases of the menstrual cycle

Parameters	Premenstrual period, mean±SD	Postmenstrual period, mean±SD	*P*-value
Pulse (beats/minute)	86.48±6.61	80.13±5.15	0.000**
Resting SBP (mmHg)	118.87±8.44	112.40±8.14	0.000**
Resting DBP (mmHg)	75.10±7.10	72.40±6.55	0.000**
Postural SBP (mmHg)	111.10±7.44	106.60±7.72	0.001**
Postural DBP (mmHg)	68.14±6.3	62.8±6.53	0.001**
CPT SBP (mmHg)	135.54±7.36	126.14±6.99	0.001**
CPT DBP (mmHg)	90.14±4.84	84.14±7.07	0.001**

SD: Standard deviation, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, CPT: Cold pressor test, **P<0.001: Highly significant

Increased sympathetic activity induced by cold water stress causes norepinephrine release and elevation of BP. Increase in BP might also be contributed by release of endothelins, prostaglandins, and angiotensin II.[23] Women pain threshold was significantly higher during premenstrual phase of the menstrual cycle, indicating increased levels of ovarian steroids and endorphins.[24]

CONCLUSIONS

Our study showed statistically significantly higher difference in all parameters in premenstrual phase as compared to postmenstrual phase. This shows highest sympathetic activity during premenstrual phase. This higher sympathetic activity may be correlated with higher progesterone levels during the premenstrual phase of the menstrual cycle. This correlates to the symptoms of premenstrual syndrome which has hormonal and neural basis.

REFERENCES

1. Zaafrane F, Faleh R, Melki W, Sakouhi M, Gaha L. An overview of premenstrual syndrome. J Gynecol Obstet Biol Reprod (Paris) 2007;36:642-52.
2. Helms JM. An overview of medical acupuncture. Altern Ther Health Med 1998;4:35-45.
3. Cronje WH, Studd JW. Premenstrual syndrome and premenstrual dysphoric disorder. Prim Care 2002;29:1-12, 5.
4. Abplanalp JM, Livingston L, Rose RM, Sandwisch D. Cortisol and growth hormone responses to psychological stress during the menstrual cycle. Psychosom Med 1977;39:158-77.
5. Woods NF, Most A, Longenecker GD. Major life events, daily stressors, and perimenstrual symptoms. Nurs Res 1985;34:263-7.
6. Gannon L, Luchetta T, Pardie L, Rhodes K. Perimenstrual symptoms: Relationships with chronic stress and selected lifestyle variables. Behav Med 1989;15:149-59.
7. Gollenberg AL, Hediger ML, Mumford SL, Whitcomb BW, Hovey KM, Wactawski-Wende J, *et al*. Perceived stress and severity of perimenstrual symptoms: The biocycle study. J Womens Health (Larchmt) 2010;19:959-67.
8. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385-96.
9. Deuster PA, Adera T, South-Paul J. Biological, social, and behavioral factors associated with premenstrual syndrome. Arch Fam Med 1999;8:122-8.
10. 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.
11. Saleh TM, Connell BJ. Role of oestrogen in the central regulation of autonomic function. Clin Exp Pharmacol Physiol 2007;34:827-32.
12. Genazzani AR, Stomati M, Morittu A, Bernardi F, Monteleone P, Casarosa E, *et al.* Progesterone, progestagens and the central nervous system. Hum Reprod 2000;15 Suppl 1:14-27.
13. Chatterjee S, Aditya S, Tibarewala DN. A comparative study between females of prepubertal and reproductive age groups to explore how HPG-axis affects the autonomic control over cardiac activity. Indian J Biomech 2009; 7-8:233-6.
14. Matsumoto T, Ushiroyama T, Morimura M, Moritani T, Hayashi T, Suzuki T, *et al.* Autonomic nervous system activity in the late luteal phase of eumenorrheic women with premenstrual symptomatology. J Psychosom Obstet Gynaecol 2006;27:131-9.
15. Strauss B, Schultheiss M, Cohen R. Autonomic reactivity in the premenstrual phase. Br J Clin Psychol 1983;22 Pt 1:1-9.
16. Hastrup JL, Light KC. Sen differences in cardio vascular stress response modulation as a function of menstrual phase. J Psychosom Res 1984;28:475-83.
17. Minakshi LP, Mangala AK, Afroz S, Nanda SD, Sudhir CP. Effect of premenstrual stress on cardio vascular system and central nervous systems. J Obstel Gynecol India 2006;56:156-8.
18. Kondo M, Hirano T, Okamura Y. Changes in autonomic nerve function during the normal menstrual cycle measured by the coefficient of variation of R-R intervals. Nihon Sanka Fujinka Gakkai Zasshi 1989;41:513-8.
19. 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.
20. Gouva L, Tsatsoulis A. The role of estrogens in cardiovascular disease in the aftermath of clinical trials. Hormones (Athens) 2004;3:171-83.
21. Guyton AC, Hall JE. Neural Regulation of Circulation and Rapid Control of Arterial Pressure: Textbook of Medical Physiology. 12th ed. New Delhi: Elsevier; 2011. p. 206-7.
22. Saeki Y, Atogami F, Takahashi K, Yoshizawa T. Reflex control of autonomic function induced by posture change during the menstrual cycle. J Auton Nerv Syst 1997;66:69-74.

23. Velasco M, Gómez J, Blanco M, Rodriguez I. The cold pressor test: Pharmacological and therapeutic aspects. Am J Ther 1997;4:34-8.
24. Hellström B, Lundberg U. Pain perception to the cold pressor test during the menstrual cycle in relation to estrogen levels and a comparison with men. Integr Physiol Behav Sci 2000;35:132-41.

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