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Variations in Blood Pressure and Pulse Rate in Phases of Menstrual Cycle in women with Primary Dysmenorrhea

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Abstract
Introduction: *Menstrual cycle include changes that occur at intervals in the uterus, ovaries, vagina during reproductive age to make procreation possible. The biological activity of the menstrual cycle is regulated by coordination between hypothalamic, pituitary and ovarian hormones. Many females suffer from dysmenorrhea, painful cramping sensation in the lower abdomen during menstruation. Reproductive hormones primarily estrogen, modulate cardiovascular function through a number of mechanisms, including induced activation of hypothalamic pituitary adrenal and sympatho-adreno-medullary systems and also through direct vasodilatory effect on the blood vessels. There appears to be a correlation between the hormonal levels in females and the ANS control of their cardiac activity. This study was designed to determine the effect of different phases of menstrual cycle on various physiological parameters like blood pressure and pulse rate in healthy premenopausal females who suffer from primary dysmenorrhea.Methods This cross sectional study was carried out on healthy female volunteers in the age group of 15 to 45 years. A total of 50subjects were included in the study using a predesigned proforma and by measuring physiological parameters of weight, height and BMI during the two major phases of menstrual cycle, follicular and luteal phases. The severity of dysmenorrhea was assessed by a scoring system reported by Anderch and Milsom. Blood pressure& pulse rate were measured once during the follicular phase (on average 9th day of cycle) and once during the luteal phase (on average 25th day of cycle)*
Results: *It has been observed that sympathetic nervous activities predominate the luteal phase whereas parasympathetic activities mark the follicular phase. A significant increase occurred in pulse rate, SBP, DBP and MAP during the luteal phase as compared to the follicular phase of the menstrual cycle. Pulse, SBP, DBP, MAP changes that occurred during the course of menstrual cycle had a relationship with dysmenorrhea. All these parameters increased more significantly in women suffering from dysmenorrhea. Mean pulse rate calculated for the entire menstrual cycle was more in women suffering from dysmenorrhea as compared to those who did not report of any such complaint. These findings point towards sympathetic over activity in females with dysmenorrhea. Dysmenorrhea has been shown to be associated with stress directly too.*
Conclusion: *Avoiding stress per se and learning techniques to alleviate it would be definitely of immense relevance in controlling the pain associated with monthly periods in women. Therefore, keeping our womenfolk happy and stress free may be a major step forward in reducing both prevalence and severity of dysmenorrhea.*
Key words: *Blood Pressure, Pulse Rate,Menstrual Cycle, Dysmenorrhea*

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I. Introduction

One of the most important attributes of female body that makes it the seat of procreation is menstrual cycle. Menstrual cycle is a cycle of natural changes that occurs in the uterus and ovaries as an essential part of making sexual reproduction possible.[1,2] The first cycle usually begins between twelve and fifteen years of age, a point in time known as menarche.[3] The biological activity of the menstrual cycle is created by coordination among hypothalamic, hypophyseal and ovarian hormones.[4]

Menstrual cycle has been divided into two major phases, one before ovulation known as follicular phase and one after ovulation known as luteal phase. Menstruation in many females is associated with painful cramping sensation in the lower abdomen. It is known as dysmenorrhea. Dysmenorrhea is one of the most frequently encountered gynecologic disorders.[5]It is often accompanied by fatigue, dizziness, sweating, headaches, back ache, nausea, vomiting, diarrhea, all occurring just before or during menses. [5,6]More than 50% of post-pubescent menstruating women are affected by dysmenorrhea, with 10% to 12% of them having severe dysmenorrhea with incapacitation for 1 to 3 days each month.[7,8,9]Dysmenorrhea is most common in women between the ages of 20 and 24 years, with most of the severe episodes occurring before 25 years of age.[10]It has been classified into two types: Primary dysmenorrhea and secondary dysmenorrhea.

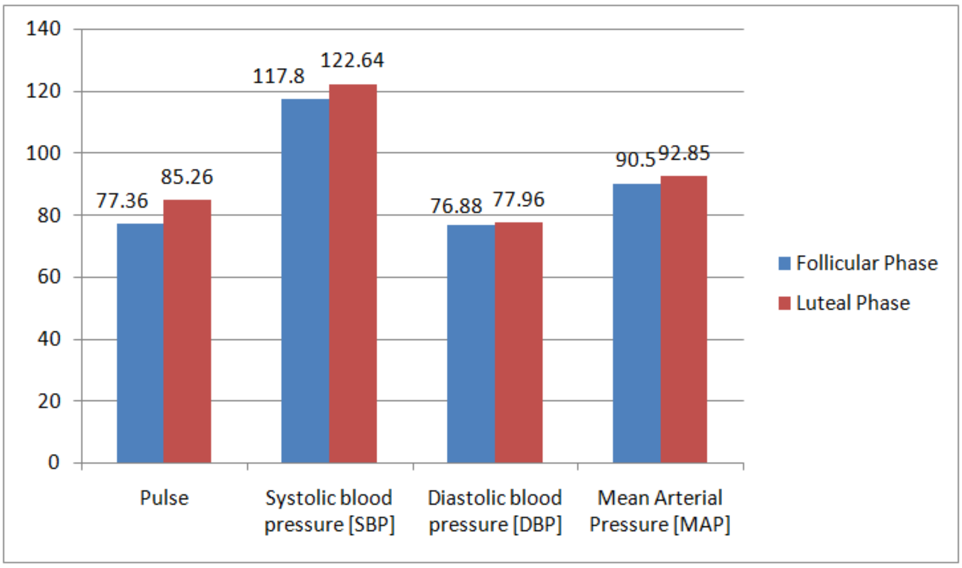
Primary dysmenorrhea is painful menstruation seen only in ovulatory cycles usually developing within 6 to 12 months of menarche. It has no pathology or organic basis.[5,6,11]Secondary dysmenorrhea is usually due to pelvic pathology . It is not common in adolescent girls.The causes of secondary dysmenorrhea include endometriosis, presence of the intrauterine device (IUD), pelvic inflammatory disease (PID) etc. In women with anovulatory cycles, the menstrual pain is likely to be secondary dysmenorrhea.[12]Some of the symptoms associated with severe forms of dysmenorrhea are similar to that of premenstrual syndrome (PMS) with both conditions having no organic basis. Premenstrual syndrome are recurrent variable somatic, psychological and emotional symptoms that develop during the 7-14 days before the onset of menses and are ameliorated by the onset of menstruation in women who are in the reproductive age group of 20-40 years.[13] Reproductive hormones primarily estrogen, may modulate cardiovascular function through a number of mechanisms, including induced activation of hypothalamic pituitary adrenal and sympatho-adreno-meduallary systems.[14,15]Blood pressure and pulse rate are the two major indicators of the cardiovascular function of our body. The levels of reproductive hormones change with the different phases of menstrual cycle[16], altering the cardiovascular functions accordingly. These variations can be monitored by observing the changes in BP and pulse rate occurring during the two main phases of menstrual cycle, follicular and luteal phases. Estrogen is a known vasodilator, hence cardio-protective in nature. The vasodilatory actions of estrogen are peripheral and central. Peripherally estrogen is active both on vascular smooth muscle and endothelial cells where functionally competent estrogen receptors have been identified.[17] Estrogen administration promotes vasodilation in humans and in experimental animals, mainly by stimulating prostacyclin and nitric oxide synthesis by endothelial NO synthase [17,18] The present study was targeted at further unveiling the effect of menstrual cycle on pulse and BP and exposing the correlation if any between these functional parameters and occurrence of dysmenorrhea.

II. Materials And Methods

This was a cross sectional study .It was carried out on healthy female volunteers in the age group of 15 to 45 years. *Inclusion Criteria included healthy female volunteers of MBBS 1st year, 1st,2nd and 3rd years of PG courses and the faculty from different departments of the institute; volunteers in the age group 15 – 45 years; subjects willing to participate; subjects experiencing menstruation; all the subjects satisfying the criteria of being free from any cardiovascular diseases and any other systemic illnesses. The exclusion criteria encompassed any volunteer having acute illness on the day of examination; on oral contraceptive medications; on any weight reduction diet or exercise regime; present or past history of any systemic illness including cardiovascular diseases such as hypertension; family history of hypertension and obesity*. Based on the said inclusion and exclusion criteria, a total of 50subjects were included in the study using a predesigned proforma and by measuring physiological parameters of weight, height and BMI during the two major phases of menstrual cycle, follicular and luteal phases. An informed consent was obtained from the subjects. Participants were asked to report their menstruation characteristics based on their experience over the last twelve months. The first day of bleeding was to be considered as the first day of cycle. Duration of bleeding was to be defined by the first day of the appearance of any spots until the complete spotlessness. Physical activity was measured using a semantic scale in which participants were asked to rate their physical activity from 'inactive' to 'very active.' The severity of dysmenorrhea was assessed by a scoring system reported by Anderch and Milsom [1982].[19] Blood pressure was measured once during the follicular phase (on average 9th day of cycle) and once during the luteal phase (on average 25th day of cycle). The subjects were explained in detail, the procedure of blood pressure recording, the purpose of the study and they were reassured that the procedures would not be harmful.Blood pressure was measured *in the sitting position*on right arm by auscultatory method using a standardizedmercury sphygmomanometer of a reputed brand and appropriate size cuff. Three separate blood pressure readings were taken on each subject at two minutes' interval. The BP readings were expressed to the nearest 2mm of Hg. The average of the last two readings for both systolic and diastolic BP was recorded.

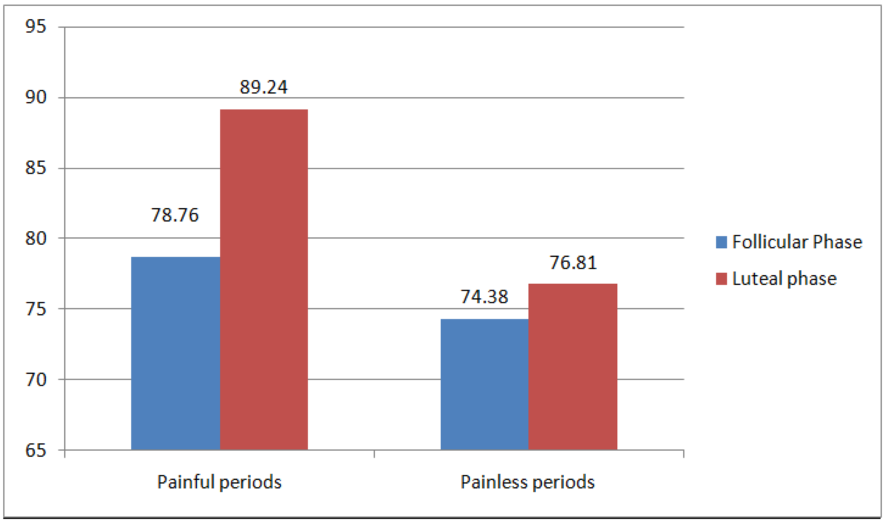
III. Observations And Results

Fig 1:- Effect of follicular and luteal phases of menstrual cycle on pulse, Systolic blood pressure [SBP], Diastolic blood pressure [DBP] and Mean Arterial pressure [MAP].



*P<0.001 for all parameters in Follicular vs. Luteal phase

Fig 2:- Variation in pulse rate occurring during different phases of menstrual in subjects suffering and not suffering from dysmenorrhea.



*P<0.001 for all parameters in Follicular vs. Luteal phase

Table 1:- Association of Mean pulse calculated for the entire menstrual cycle with the occurrence of Dysmenorrhea.

Parameter	In subjects with Dysmenorrhea	In subjects without Dysmenorrhea	T value	P value
Mean pulse	84.00±8.82	75.59±4.73	3.564	0.001

Table 2:- Relation of fluctuation in SBP during follicular and luteal phases with severity of Dysmenorrhea

History of painful periods	Number of subjects	SBP [Follicular phase]	SBP [Luteal phase]	T value	P value
No pain	16	119.50±11.76	122.25±11.81	3.37	0.004
Mild pain	6	114.67±6.02	116.67±4.84	2.73	0.041
Moderate pain	10	118.20±17.16	123.20±16.89	5.23	0.001
Severe pain	18	117.11±10.95	124.67±9.98	9.43	0.000

Table 3:-Association between shoot up in SBP occurring during luteal phaseand follicular phase and occurrence of Dysmenorrhea

History of painful periods	Number of subjects	SBP[mmHg] Follicular phase	SBP[mmHg] Luteal phase	T value	P value
No pain	16	119.50±11.76	122.25±11.81	3.37	0.004
Pain	34	117.00±12.21	122.82±11.90	9.26	0.000

Fig.3

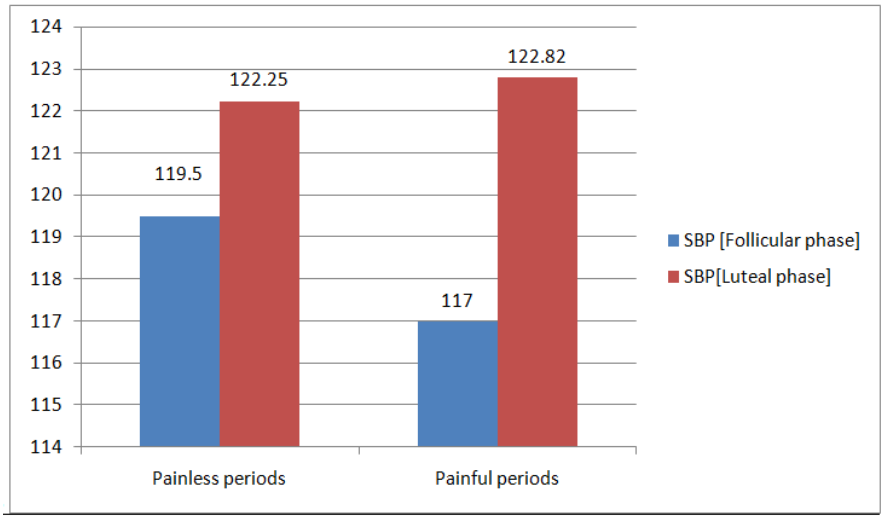


Table 4:- Relation of variation in DBP during follicular and luteal phases with severity of Dysmenorrhea.

History of painful periods	Number of subjects	DBP [Follicular phase]	DBP [Luteal Phase]	T value	P value
No pain	16	77.62±6.33	77.63±5.98	0.00	1.00
Mild pain	6	75.33±4.50	76.33±4.27	2.23	0.076
Moderate pain	10	75.60±7.93	77.00±7.61	1.76	0.111
Severe pain	18	77.44±7.28	79.33±5.98	1.96	0.066

Table 5:- Association between fluctuation in DBP during Follicular and luteal phases of menstrual cycle and occurrence of Dysmenorrhea &Relation between rise in MAP during Follicular phase and luteal phase and presence of dysmenorrhea

History of painful periods	Number of subjects	DBP[mmHg] Follicular phase	DBP[mmHg] Luteal phase	T value	P value
No pain	16	77.62±6.33	77.62±5.98	0.00	1.00
Pain	34	76.53±6.96	78.12±6.22	2.84	0.008
		MAP[mmHg] Follicular phase	MAP[mmHg] Luteal phase		
No pain		91.58±7.86	92.50±7.69	1.46	0.16
Pain		90.01±8.25	93.01±7.39	6.86	0.000

Fig.4

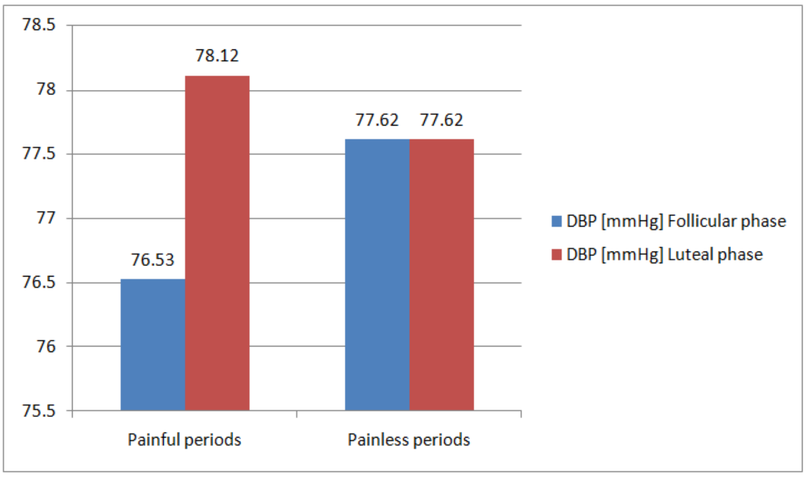


Fig.5

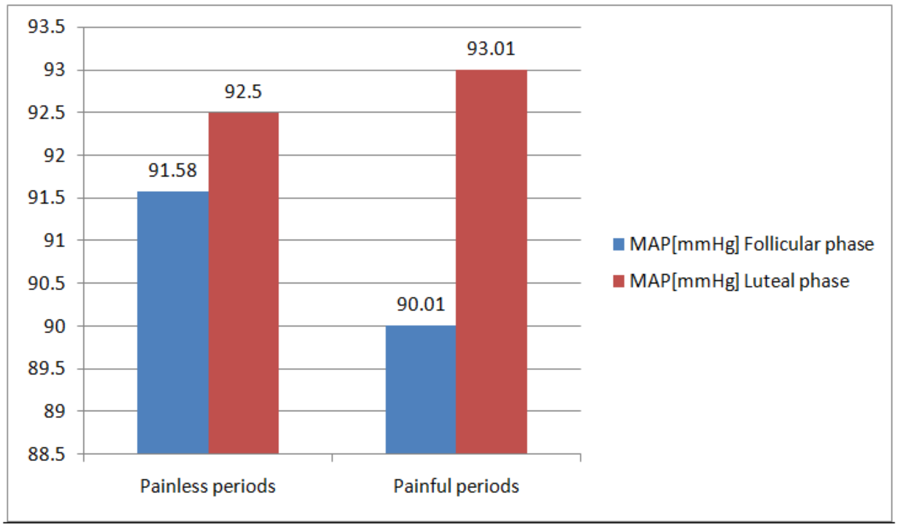


Table 6:- Relationship between upsurge in MAP during Follicular phase and Luteal phase and severity of Dysmenorrhea

History of painful periods	Number of subjects	MAP[mmHg] Follicular phase	MAP[mmHg] Luteal phase	T value	P value
No pain	16	91.58±7.86	92.50±7.68	1.46	0.16
Mild pain	6	88.44±4.66	89.77±3.94	2.98	0.033
Moderate pain	10	89.80±10.70	92.40±10.36	3.58	0.006
Severe pain	18	90.66±8.00	94.44±7.21	5.76	0.000

IV. Discussion

The current study shows that 68% of healthy subjects (34 out of 50) included in the study suffered from dysmenorrhea. Out of these 50 subjects, 12%, 20% and 36% suffered from mild, moderate, and severe dysmenorrhea respectively (categorized on the basis of Andersch and Milsom scoring scale).[20] The results of this study showed that the prevalence of dysmenorrhea was 76.1% (n = 643); of these, 26.6% described their menstrual pain as mild, 32.0% as moderate and 41.4% as severe.[21] Ibrahim et al showed the prevalence of severe dysmenorrhea among the sufferers was 38.6%. [22]The percentage of subjects suffering from severe dysmenorrhea determined by present study (36%) wasquite high like that shown by Ibrahim et al (2015).[22]However, lesser prevalence of severe dysmenorrhea has been reported by other studies in North America and Europe(15%).[5,6]Another study reported presence of dysmenorrhea in 84.2% girls and absence of dysmenorrhea in 15.8%.[23] Using Verbal Analogue Scale (VAS), 34.2% of girls experienced severe pain, 36.6% moderate and 29.2% had mild pain.[23]The causes of discrepancies may be attributed to the use of different scales for grading pain.[24]Present study depicted that the mean Systolic Blood Pressure (SBP) of subjects increased significantly ($p<0.05$) by 5.28 mmHg during luteal phase compared to follicular phase of the menstrual cycle. Mean Diastolic Blood Pressure (DBP) and MAP also showed a significant rise by 1.08 and 2.35 mmHg respectively. It is in line with findings of a study conducted by Manhem et al, that documented SBP was significantly higher during the luteal phase as compared to the follicular phase.[25]A study conducted by Dunne et al showed blood pressure was highest at the onset of menstruation and lowest during days 17-26 (mid-luteal phase).[26] Adjusted diastolic blood pressure was higher in the follicular than in the luteal phase.[26] The antihypertensive role of estrogen is well established.[18,27-33] The plasma level of estrogen is lowest during the late luteal and early follicular (menstrual) phases. Estrogen plays a role in increasing vagal and reducing sympathetic activity by enhancing the cholinergic muscarinic activity at central and peripheral levels.[34]In the late luteal phase, plasma levels of estrogen fall. It could be a reason for sympathetic activity taking over in this phase. Progesterone stimulates aldosterone production and at the same time, inhibits binding of the same with its receptors in the kidney.[35] Hence mitigating the sodium and fluid retaining effect of aldosterone. Towards the end of the luteal phase and the beginning of menstrual phase, the progesterone levels fall leading to termination of its aldosterone opposing action. Therefore, it may be presumed there occurs fluid and sodium retention causing a surge in blood pressure. Psychological stress contributes to the development of hypertension in humans.[36] Estrogen, has been shown to prevent stress-induced pressor responses in females by acting on estrogen receptor- alpha in the medial amygdala.[37] In normal women, angiotensin II (AngII) and plasma renin activity (PRA) are elevated during the luteal phase of the menstrual cycle.[38-41]However, the effects are nullified by high circulating levels of estrogen.[30,42-46] Towards the end of the luteal phase the levels of estrogen fall.This effect of estrogen may get thwarted resulting in rise in BP. The current evidences indicate that estrogen can significantly lower both systolic and diastolic blood pressure in postmenopausal hypertensive women.[47]Based on these reports, the rise in SBP, DBP and MAP observed in current study can be attributed to the falling levels of estrogen during the latter part of the luteal phase. Contrasting results were shown by a study conducted by Hassan et al.[14] It showed that diastolic and mean arterial pressures were significantly reduced in luteal phase, whereas heart rate, body temperature, foot skin temperature and body weight were significantly increased, as compared with the follicular phase of the cycle.[14]The discrepancy could be because the exact timing hasn't been specified. A study showed that BP and HR remain unchanged during the menstrual cycle.[48] Despite huge fluctuations in levels of sex hormones, consistent differences in blood pressure between the follicular and luteal phases of the menstrual cycle have not been clearly documented.[49-51] The present study can be further substantiated by the results of a study conducted by Kiran Singh et al, that concluded women with primary dysmenorrhea had more sensitive responses to the sympathetic-adrenal-medullary axis system than eumennorheic women throughout the entire menstrual cycle.[52]Present study corroborated that the mean pulse of subjects increased significantly ($p< 0.05$) by 7.9 beats per minute during luteal phase compared to follicular phase of the menstrual cycle. The results are in coherence with the findings of studies conducted by Manhem et al[25] Girija and Veeraiah[53], Mckinley et al[54] and Little et al[55], all stating that heart rate was significantly higher during the luteal phase as compared to the follicular phase. The upsurge in heart rate during the luteal phase could be attributed to increased sympathetic and withdrawn parasympathetic activities during the luteal phase.[56-58]Present study also showed that mean pulse calculated for the entire menstrual cycle was significantly higher ($p <0.05$) in subjects suffering from dysmenorrhea than those with no such history. It can be accredited to the findings of a study that stated young women with primary dysmenorrhea had significantly reduced heart rate variability throughout the menstrual cycle in the form of decreased vagal and increased sympathetic activity reflected by increased mean heart rate.[52]

V. Conclusion And Summary

Menstrual cycle is a cycle of natural changes that occurs in the uterus and ovaries as an essential part of making sexual reproduction possible.The biological activity of the menstrual cycle is created by coordination among hypothalamic, hypophyseal and ovarian hormones. Many females suffer from dysmenorrhea, painful cramping sensation in the lower abdomen during menstruation. Reproductive hormones primarily estrogen, modulate cardiovascular function through a number of mechanisms, including induced activation of hypothalamic pituitary adrenal and sympatho-adreno-medullary systems and also through direct vasodilatory effect on the blood vessels. There appears to be a correlation between the hormonal levels in femalesand the ANS control of their cardiac activity. It has been observed that sympathetic nervous activities predominate the luteal phase whereas parasympathetic activities mark the follicular phase. The major finding of this study is Significant increase occurred in pulse rate, SBP, DBP and MAP during the luteal phase as compared to the follicular phase of the menstrual cycle. The primary focus of the study was to expose the relationship between the fluctuations observed in physiological parameters of pulse and BP during the menstrual cycle and dysmenorrhea. Pulse, SBP, DBP, MAP changes that occurred during the course of menstrual cycle had a relationship with dysmenorrhea. All these parameters increased more significantly in women suffering from dysmenorrhea. Mean pulse rate calculated for the entire menstrual cycle was more in women suffering from dysmenorrhea as compared to those who did not report of any such complaint. These findings point towards sympathetic over activity in females with dysmenorrhea.

The major lacunae of the present study were less number of subjects included in the study; unavailability of equipment for doing HRV analysis to determine the autonomic status of the subjects; inability to follow up the subjects in all the phases of the menstrual cycle and absence of subjects below and above the reference age for menarche.

Dysmenorrhea has been shown to be associated with stress directly too. Avoiding stress per se and learning techniques to alleviate it would be definitelyof immense relevance in controlling the pain associated with monthly periods in women. Therefore, keeping our womenfolk happy and stress free may be a major step forward in reducing both prevalence and severity of dysmenorrhea.

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