Indian J. Applied & Pure Bio. Vol. 27(1), 127-132 (2012).

Influence of three phases of menstrual cycle on pulmonary functions

***Dimple Arora, *Parminder Kaur, **Mohit Arora and ***Urmil Gupta**

*Department of Physiology, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar (INDIA)
**Department of Orthopedics, Fortis-Escorts Health Care Centre, Amritsar (INDIA)
***Department of Physiology, Indira Gandhi Medical College, Shimla (INDIA)

Abstract

Menstrual cycle is an integral part of life of women. There is widespread agreement that changes in the levels of estrogen and progesterone associated with menstrual cycle also affect different systems of the body. Levels of estrogen and progesterone are maximum in the secretory phase and minimum just before the menstruation. The purpose of this study was to confirm the probable effects of female hormones on lung functions in normal women in different phases of menstrual cycle. The study included 40 females in the age group of 15-45 years. Pulmonary function tests were done in these study subjects in all the three phases of menstrual cycle namely follicular, secretory and menstrual. The mean value of lung function tests i.e. FVC, FEV1, PEFR, FEF 25-75%, PEF 200-1200 in secretory phase were significantly higher than in menstrual phase ($p<0.005$). The PFTs in menstrual phase were even lower than in the follicular phase ($p<0.04$). It was concluded that respiratory parameters of women in reproductive age group show significant variation during different phases of menstrual cycle.

Key words: Menstrual cycle, pulmonary functions, progesterone, estrogen.

The association between menstrual cycle[21] and lung functions[12] in normal females has long been recognized[11,13]. The pathophysiology of this is still not proved. During various phases of menstrual cycle, the blood level of female hormones *i.e.* progesterone and/or estrogen, vary[17,18,5]. Studies suggest that progesterone and estrogen levels strengthen the respiratory musculature and increase the relaxation of bronchial smooth muscles[1]. This variation has been cited as the cause of change in lung functions during various phases of menstrual cycle[7,1,9]. Some other studies also reported significant variation in pulmonary functions during different phases of menstrual cycle[14,16].

Measurement of lung functions is done by spirometry. Lung functions include quantification of gas volumes contained in lungs under certain circumstances and the rate at which these gases are expelled from the lungs[9]. The knowledge of these normal spirometric values is very important. It helps to differentiate any abnormality in pulmonary functions in patients suffering from ventilatory diseases[19].

It is well known that some female asthmatic patients experience aggravation of asthma symptoms during the premenstrual or menstrual phase of their cycle[2]. This has been referred to as perimenstrual asthma (PMA)[10]. PMA has been documented in 30% to 40% of asthmatic women[13].

The known influences of the menstrual cycle on asthma support a role for female sex hormones on the changing expression of asthma during adolescence[1, 8]. The FEV_1 was significantly lower in the girls during menstruation period than in the girls who were not on menstruation (77.5 ± 10.2 vs. 80.4 ± 8.6, $p = 0.03$)[20].

The purpose of our study was to confirm the probable effects of the three phases of menstrual cycle on pulmonary functions.

The study was conducted in the department of Physiology, Indira Gandhi Medical College, Shimla (India) from December 2005 to June 2006. Data were collected and examined by the first and fourth authors working there at that time and then the manuscript was prepared in association with others. The study involved 40 female medical students of the menstrual age group studying in the undergraduate and postgraduate classes of the college.

The present study entailed comparison of pulmonary functions in three phases of menstrual cycle in 40 females with regular menstrual cycle in the range of 28 ± 2 days. They were divided into two groups as following:

Group I – included 20 females in the age group < 30 years.
Group II – included 20 females in the age group > 30 years.

A detailed menstrual history of the study subjects was taken so that their pulmonary function tests could be done in various phases of menstrual cycle. The study subjects were explained in detail about the purpose and procedures of the study, their consent for the study was sought; and they were assured of keeping confidentiality of this study.

Inclusion and exclusion criteria: The following criteria were considered while selecting a case for the study:

1. Women with regular menstrual cycle were included in the study.

2. Women on hormonal therapy, post hysterectomy status and any respiratory illness were excluded from the study.

3. The subjects not performing properly and not meeting the standardization criteria were excluded from the study.

The pulmonary function tests of the

study subjects were done in various phases of menstrual cycle. The variations in pulmonary functions were then studied.

The pulmonary functions tests were done by using an electronic spirometer called Vitalograph COMPACT II. It fulfils the accuracy and precision criteria as per American Thoracic Society recommendations. It detects instantaneous expired and inspired respiratory air with a Fleisch Pneumotachograph type of flowhead. Inside the flowhead, there is a resistance in form of a series of parallel tubes which maintain laminar flow in the air passing through it. This creates differential pressure, measured by the transducer inside the instrument. The subjects were made to sit in an upright position without any back rest. They were instructed to take maximal inspiration and blow into the instrument rapidly and forcefully. Second time, they were asked to take maximal inspiration and make a prolonged forceful expiration, followed by re-inspiration from the mouthpiece. A close watch was kept to ensure that a tight seal was maintained between lips and mouthpiece of the device. The pulmonary functions were then recorded.

The spirometry done was standardized as per American Thoracic Society criteria. Three readings were taken at a sitting and the highest reading at any testing session was used in trend analysis. The readings from the instrument were recorded for each female three times during the menstrual cycle:

1. One during the first or second day of the menstrual period henceforth referred to as the menstrual phase. 2. The second reading was taken in the middle of the proliferative or follicular phase. 3. The third reading was taken in the middle of the secretory or luteal phase.

The following respiratory parameters were studied during different phases of menstrual cycle[3]:

1. Vital Capacity (VC): It is the maximum amount of air a person can expire after maximum inspiration. 2. Forced Vital Capacity (FVC): It is the volume of gas that can be expired as forcefully and rapidly as possible after maximum inspiration. 3. Forced Expiratory Volume in the first second (FEV_1): It is the volume of gas expired over the first second during the performance of a forced vital capacity. 4. Maximal Mid Expiratory Flow Rate (MMEFR or $FEF_{25-75\%}$): It is the average rate of flow during the middle half of a forced vital Volume. 5. Maximal Expiratory Flow Rate (MEFR or $FEF_{200-1200}$): It is the average flow rate for the liter of gas expired after the first 200ml during a forced expiratory volume maneuver. 6. Peak Expiratory Flow Rate (PEFR) – It is the maximum flow rate attainable at any time during a forced expiratory volume maneuver.

Three pairs were made for the analysis of the data collected. These are as following:

Pair 1 — Follicular and menstrual
Pair 2 – Secretory and menstrual
Pair 3 – Follicular and secretory

The comparison is shown in table-3.

After recording the data, the parameters stated above were analysed statistically by applying the student's 't' test and p values below 0.05 and 0.01 were considered significant and highly significant statistically respectively.

Table-1. Pulmonary function tests in females in theage group< 30 years

S. No.	Pulmonary function test	Follicular phase (Mean ± S. D)	Secretory phase (Mean ± S. D)	Menstrual phase (Mean ± S. D)
1	VC (Lt)	2.82 ± 0.39	2.94 ± 0.37	2.69 ± 0.39
2	FVC (Lt)	2.85 ± 0.39	3.00 ± 0.41	2.67 ± 0.36
3	FEV 1 (Lt)	2.67 ± 0.32	2.82 ± 0.33	2.46 ± 0.38
4	FEV 1/FVC (%)	94.0 ± 5.05	94.4 ± 6.11	92.2 ± 8.1
5	PEFR (Lt/min)	328.6 ± 69.8	356.0 ± 65.58	313 ± 69.83
6	FEF 25-75 (Lt/sec)	3.77 ± 0.67	4.04 ± 0.68	3.48 ± 0.75
7	PEF 200-1200 (Lt/sec)	5.04 ± 1.03	5.43 ± 1.05	4.76 ± 1.12

Table-2. Pulmonary function tests in females in theage group>30 years

S. No.	Pulmonary function test	Follicular phase (Mean ± S. D)	Secretory phase (Mean ± S. D)	Menstrual phase (Mean ± S. D)
1	VC (Lt)	2.77 ± 0.28	2.89 ± 0.33	2.61 ± 0.28
2	FVC (Lt)	2.75 ± 0.32	2.89 ± 0.36	2.63 ± 0.32
3	FEV 1 (Lt)	2.55 ± 0.28	2.71 ± 0.29	2.36 ± 0.33
4	FEV 1/FVC (%)	93.25 ± 9.04	94.4 ± 5.71	89.90 ± 7.33
5	PEFR (Lt/min)	339.80 ± 79.96	363 ± 70.54	323 ± 72.97
6	FEF 25-75 (Lt/sec)	3.84 ± 0.73	4.06 ± 0.75	3.56 ± 0.76
7	PEF 200-1200 (Lt/sec)	4.91 ± 1.16	5.25 ± 1.05	4.73 ± 1.19

The study subjects were in the range of 18-45 years of age. Tables 1-3 show that the mean values of all the parameters of lung function tests in all the phases were higher in Group I than in Group II. The mean values of VC and FVC in both Group I and Group II were the highest in secretory phase followed by follicular phase and the lowest in menstrual phase. The mean values of all the lung functions *i.e.* FEV1, PEFR, FEF 25- 75%, PEF 200-1200, in both the groups were higher in secretory phase followed by follicular phase and the lowest in menstrual phase. The statistical significance of the difference in the values is shown in the table 3. No significant variation was found in values of FEV1/FVC in pairs 1 and 3 in both the groups.

The present study shows that respiratory parameters of women in reproductive age group show significant variation during different phases of menstrual cycle. The results of this study were consistent with the results obtained in previous studies done by Pai and Prajna and Rao *et al.*[14, 16].

The most probable cause for this increase in the lung function parameters during the secretory phase of menstruation is the hyperventilation associated with increased levels of progesterone secretion in this phase[6]. Rajesh *et al*. reported that periodic hyperventilation improves respiratory muscle strength and lung capacities[15]. Hence the studies of

Table-3. Statistical analysis of pulmonary function tests in three phases of menstrual cycle.

Sr. No.	PFTs	Group comparison	t value		p value	
			Group I	Group II	Group I	Group II
1.	VC (Lt)	Pair 1	6.432	6.365	0.000**	0.000**
		Pair 2	7.436	8.304	0.000**	0.000**
		Pair 3	4.060	4.085	0.001**	0.00**
2.	FVC (Lt)	Pair 1	5.891	4.023	0.000**	0.001**
		Pair 2	8.283	7.119	0.002**	0.000**
		Pair 3	6.007	4.731	0.000**	0.000**
3.	FEV_1 (Lt)	Pair 1	6.205	5.497	0.000**	0.000**
		Pair 2	8.922	10.68	0.000**	0.000**
		Pair 3	5.041	6.782	0.000**	0.000**
4.	FEV_1/ FVC(%)	Pair 1	1.204	1.781	0.24^{NS}	0.091^{NS}
		Pair 2	1.345	3.028	0.195^{NS}	0.007**
		Pair 3	0.550	0.886	0.589*	0.387^{NS}
5.	PEFR (Lt/Min)	Pair 1	2.032	3.961	0.056*	0.001**
		Pair 2	6.008	5.735	0.000**	0.005**
		Pair 3	5.088	4.225	0.000**	0.000**
6.	FEF 25-75% (Lt/Sec)	Pair 1	4.352	4.245	0.000**	0.000**
		Pair 2	6.567	6.178	0.000**	0.000**
		Pair 3	5.638	5.887	0.000**	0.000**
7.	PEF 200-1200 (Lt/Sec)	Pair 1	2.161	3.222	0.044*	0.004**
		Pair 2	4.350	4.317	0.000**	0.000**
		Pair 3	3.318	3.975	0.004*	0.001**

Abbreviations used in the table: Group I = Females in the age group < 30 years, Group II = Females in the age group > 30 years, Pair 1= Follicular and menstrual, Pair 2 = Secretory and menstrual, Pair 3 = Follicular and secretory, * = Significant, ** = Highly significant and ^{NS} = Not significant.

hormonal assays may be correlated with this study and effects of reduced pulmonary functions in the menstrual phase along with the remedial measures may be studied and applied.

The authors are highly thankful to Dr. S. L. Mahajan, Department of Community Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar for his invaluable guidance, masterly supervision and encouragement. Sincerest thanks are due to Dr. Priyanka Devgun, Department of

Community Medicine, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar for examining this manuscript and giving valuable suggestions and affectionate encouragement.

References :

1. Baird, D. (1967). Endocrine control of menstrual cycle. Combined Textbook of Obstetrics and Gynecology, 8th edition, chapter *7:* 50–55.
2. Beynon, H.L., N.D. Garbett and P.J. Barnes (1988) *Lancet, 2* (8607): 370-2.
3. Browne, J. E. MccLure. (1973) Post graduate Obstetrics and Gynecology, 4th edition, chapter *4:* 40–41.
4. Chandler, M. H., S. Schuldheisz, B. A. Philips and K.N. Muse (1997). *Pharmacotherapy, 17(2):* 224-34.
5. Chaudhary, S. K. (2004) Female Reproductive physiology. Concise Medical Physiology. 5th Edition, Chapter VI-10: 312-318.
6. Dempsey, J.A. *et al.* (1986). Hormones and neuro-chemicals in the regulation of breathing. Handbook of Physiology Section 3: The Respiratory System, American Physiological Society, 181-222.
7. Dutta, D.C. (2003) Physiology of Menstrual cycle. Textbook of gynecology, 4th edition, chapter *7:* 74-82.
8. Farha, S., K. Asosingh, J. Hammel, R.A. Dweik, H.P. Weideman and S.C. Erzurum (2009). Am. J. Respir Crit Care Med, *180:* 304-10.
9. Ganong, W.F. (2005). Pulmonary Function. Review of Medical Physiology. Section VII. Lange Publications. 22nd edition, *34:* 587-603.
10. Jeon, Y.H., H.J. Yang and B.Y. Pyun (2009) *J Korean Med Sci,* February; *24(1):* 20-25.
11. Karpel, J.P. and J.L. Wait (2000) *J. Crit Illness. 15:* 265-272.
12. Nowak R.M. (1996) *Annals of emergency medicine, 27:* 244-249.
13. O'Connor B. J. (1997) *Thorax. 52(7):* 608-611.
14. Pai S.R. and P. Prajna (2001) *Indian J. Physiol Sci., 33:* 81–85.
15. Rajesh C.S. (2000) *Indian J Physiology and Pharmacology. 44(4):* 442-48.
16. Rao V.S.J., A Shah and N. Nanal (1994) Specialty issue on Asthma and Allergy, July 1-3.
17. Rumball J. (2001) *The western J. of Graduate Research. 10(1):* 65-68.
18. Shaw. (1994) Physiology of Menstruation. Textbook of Gynecology, 11th edition, Chapter *3:* 51-54.
19. Slonim and Lung Chapman (1992) Volumes and its Subdivisions. Textbook of Respiratory Physiology, Fifth Edition, Chapter *3:* 22-24.
20. Tam A., D. Morrish, S. Wadsworth, D. Dorscheid, S.F. Paulman and D. Sin (2011) *BMC, 11(24):* 1472-6874.
21. Weinberger S.E. and J.M. Drazen (2001) Disturbances in respiratory function. Harrison's Principles Of Internal Medicine. 15th edition, *250:* 1446-56.