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Physiology

KEY WORDS: pregnancy, all trimesters, spirometry

STUDY OF CHANGES IN LUNG FUNCTION TEST IN PREGNANCY

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ABSTRACT

BACKGROUND: Pregnancy is characterized by various physiological changes that have an impact on multiple organ system functions and associated with various changes in pulmonary anatomy and physiology to accommodate the needs of the developing fetus. These changes in lung parameters can be assessed by spirometry, a simple, inexpensive and effective method.

AIM: To assess the changes in lung function in 1st, 2nd & 3rd trimesters during normal pregnancy.

METHODS: The study consisted of recording the pulmonary function tests in 160 female volunteers divided into four groups (each group having about 40 females) including pregnant women of various phases of gestational period 12 weeks, 24 weeks, 36 weeks in the age group of 20-35 years either primigravida or multigravida with haemoglobin count more than 10 gm% from antenatal OPD GMCH, Chandrapur. The age matched controls were the volunteers from the relatives of pregnant women who attended the OPD and from amongst the hospital staff and students. FVC, FEV1, PEFR, FEF 25-75%, MVV and ERV were recorded in all volunteers by using Spiroexcel digital spirometer, Medicaid systems. Results were expressed as mean ± S.D. and compared with Student's t test.

RESULTS AND CONCLUSION: As compared with controls, there is significant decrease in lung parameters namely, FVC, FEV1, PEFR, FEF 25-75%, MVV and ERV progressively in all the trimesters of normal pregnancy.

INTRODUCTION

Pregnancy is a period characterized by various physiological changes in female body that have influence on multiple organ system functions. These changes are suitable to adjust with the needs of the developing fetus, even in healthy women. Similarly there are notable changes in pulmonary anatomy and physiology during pregnancy. Three important changes in the configuration of the thorax that occur during pregnancy were an increase in the circumference of the lower chest wall (with increase in anteroposterior and the transverse diameters); elevation of the diaphragm (upward displacement of approximately 4 cm to 5 cm) and a 50% widening of the costal angle.(1) These changes peak around the 37th week of pregnancy and normalize within 6 months after delivery. Pulmonary function is affected by changes of the airway, thoracic cage, and respiratory drive. Additionally, capillary engorgement throughout the respiratory tract results in mucosal oedema and hyperemia. Multiple biochemical alterations like increase in progesterone, estrogen, prostaglandins, corticosteroid and cyclic nucleotide levels occur concomitantly during the course of pregnancy.(2)

Pregnancy can affect the course of pulmonary disease and vice versa. Maternal complications like preeclampsia, preterm birth, low birth weight are more commonly associated with pregnancies of asthmatic women than those in non-asthmatic women. In pregnant women with cystic fibrosis, low FEV1 is associated with preterm delivery. (3) As a consequence, pregnant women with altered lung function need regular assessment of symptoms and by spirometry too.

Pulmonary function tests provide an accurate knowledge of physiological changes in the pulmonary functions occurring during pregnancy. Their precise knowledge allows the clinician to verify the extent of the adaptation in pregnant women and helps to avoid unnecessary treatment of physiological changes misinterpreted as pathological changes in reference to pre-pregnancy standards. Assessment of pulmonary functions in normal women during pregnancy is also necessary for better antenatal care, in the assessment of fitness for anaesthesia and to know the progress of pre-existing lung diseases.

With this context, we would like to evaluate the pulmonary functions of normal gestation pregnant women at Government medical college and hospital, Chandrapur in the 1st, 2nd & 3rd trimesters and to compare them with those of normal non pregnant women with a view to define the standards of normalcy in pregnancy and also to document expected changes in pulmonary parameters.

METHODOLOGY

The present study was a prospective case control study conducted in the antenatal outpatient department at Government medical college and hospital, Chandrapur. It consists of recording the lung function tests in 160 female volunteers in the age group of 20-35 years which were divided into four groups (each group having about 40 females) including pregnant women of various phases of gestational period 12 weeks (Group 2), 24 weeks (Group 3), 36 weeks (Group 4), either primigravida or multigravida and the age matched control group (Group 1), mainly the volunteers from the relatives of pregnant women who attended the OPD and from amongst the hospital staff and students. The subjects considered for this study were with haemoglobin count more than 10 gm%.

All the subjects were called for spirometric tracings in the morning between 11am to 2pm (2 to 3 hrs after breakfast) in order to keep uniform conditions for recording the tests. Prior to performing LFT, the procedure was thoroughly explained to each subject, the queries and apprehensions of the subjects were satisfied emphasizing the need to maintain an effective seal with lips around the mouth piece and also the use of nose clip during the procedure. Each subject would make to relax for minimum 5 minutes prior to performing the PFT procedure. Two to three tracings were taken out of which the best is taken as final reading.

INCLUSION CRITERIA:

Selection of subjects:

1. Uncomplicated pregnant women.
2. Age group (20-35) years
3. Physically and mentally capable of adequate co-operation during the performance of the tests.
4. Volunteers not having any acute illnesses like upper respiratory tract infection, lower respiratory tract

infection, etc.

EXCLUSION CRITERIA:

Women suffering from anaemia, multiple pregnancy, hydramnios, high BP, asthma, tuberculosis, cardiovascular disease, eclampsia, smoking, sign of any bony deformity of the thoracic cage, or those on chronic therapy for any other ailment were excluded from the study.

After taking informed written consent from each subject, a detailed history and complete clinical examination was done to rule out the exclusion criteria. The height as well as weight of the subject was noted at the room temperature on the day of assessment of lung function tests. The following lung parameters were recorded in Test and Control subjects.

1. FVC: Forced vital capacity- the maximum volume of air expired after a maximum inspiration.
2. FEV1: Forced expiratory volume in first second- the fraction of vital capacity expired during the first second of forced expiration.
3. FEF25%-75%: Forced mid expiratory flow
4. PEFR: Peak expiratory flow rate- maximum velocity of flow with which air is forced out of the lungs.
5. MVV: Maximum voluntary ventilation- maximum volume of gas that can be breathed per minute by maximal voluntary effort.
6. ERV: Expiratory reserve volume- volume of air that can be expired with a maximum expiratory effort after normal tidal expiration.

RECORDING OF PFTS

The relaxed subject, in a standing position, was prepared to grip the sterile mouth piece the use of nose clip during the procedure. When the subject was confident and familiar with the procedure, she was asked first to perform maximal inspiration after a deep expiration. The subject then instructed to expire with maximal effort (maximal expiration). The mouth piece was then removed and the actual, predicted and percentage of predicted values were printed for analysis. Each subject (Test or Control) was asked to repeat the maximum forced expiratory effort three times, each time with adequate rest in between, and the best reading of the three was considered for analysis.

All these parameters in control group having non pregnant normal female were compared with the parameters in pregnant women in each trimester (1st, 2nd and 3rd). The protocol of the study was approved by the institutional ethical committee. Statistical Analysis was done using Graph pad prism 6 Software. Unpaired t test was used to compare the mean values.

RESULTS

Table 1 shows mean age, weight, height in women of control group and all three trimesters

	Age (years) (Mean ±S.D.)	Weight (kgs) (Mean ±S.D.)	Height (cms) (Mean ±S.D.)
GROUP I	26.05± 4.68	47.95± 6.42	153.85± 5.22
GROUP II	25.5± 8.28	48.27± 5.48	150.1± 3.5
GROUP III	26.93± 4.94	51.3± 7.73	151.4± 5.46
GROUP IV	26.5± 4.94	59.8± 8.2	153.8± 6.42

Table 2: Comparison of mean values of different lung function parameters between control and Ist trimester pregnant women

Lung Parameters	Group I (Mean ±S.D.)	Group II (Mean ±S.D.)	P Value
FVC	2.565 ± 0.33	2.143 ± 0.3	p < 0.001
FEV1	2.052 ± 0.26	1.83 ± 0.24	p < 0.001
PEFR	7.687 ± 1.15	6.95 ± 1.26	p = 0.004
FEF 25 % -75 %	3.241 ± 0.76	3.01 ± 1.16	p = 0.146
MVV	129.57 ± 8.02	121 ± 6.86	p < 0.001
ERV	0.77 ± 0.13	0.71 ± 0.16	p = 0.027

P<0.05-Significant, p<0.01 or p<0.001-Highly Significant
As compared with controls, there is significant decrease in lung parameters namely, FVC, FEV1, PEFR, MVV and ERV in first trimester of normal pregnancy.(3)

Table 3: Comparison Of Mean Values Of Different Lung Function Parameters Between Control And Iind Trimester Pregnant Women

Lung Parameters	Group I (Mean ±S.D.)	Group III (Mean ±S.D.)	P Value
FVC	2.565 ± 0.33	2.288 ± 0.45	p < 0.001
FEV1	2.052 ± 0.26	1.75 ± 0.37	p < 0.001
PEFR	7.687 ± 1.15	6.496 ± 1.43	p < 0.001
FEF 25 % -75 %	3.241 ± 0.76	2.669 ± 0.76	p < 0.001
MVV	129.57 ± 8.02	117.11 ± 3.9	p < 0.001
ERV	0.77 ± 0.13	0.678 ± 0.08	p < 0.001

P<0.05-Significant, p<0.01 or p<0.001-Highly Significant
On comparison with controls, lung parameters namely, FVC, FEV1, PEFR, FEF 25% -75%, MVV and ERV are significantly decreased in pregnant women of second trimester.

Table 4: Comparison Of Mean Values Of Different Lung Function Parameters Between Control And Iiird Trimester Pregnant Women

Lung Parameters	Group I (Mean ±S.D.)	Group IV (Mean ±S.D.)	P Value
FVC	2.565 ± 0.33	1.502 ± 0.44	p < 0.001
FEV1	2.052 ± 0.26	1.26 ± 0.37	p < 0.001
PEFR	7.687 ± 1.15	5.558 ± 1.58	p < 0.001
FEF 25 % -75 %	3.241 ± 0.76	2.619 ± 1.16	p = 0.003
MVV	129.57 ± 8.02	111.38 ± 6.75	p < 0.001
ERV	0.77 ± 0.13	0.645 ± 0.14	p < 0.001

P<0.05-Significant, p<0.01 or p<0.001-Highly Significant

The decline in above lung parameters is highly significant in third trimester.

DISCUSSION

In pregnancy hormonal changes and progressive increase in abdominal volume may have mechanical and functional impact on respiratory function, however an increase in transverse diameter of the chest, resulting from a widened sub costal angle, opposes the effect of the enlarging pregnant uterus and elevated diaphragm, leaving pulmonary function altered, but not compromised during pregnancy.

In the present study, different lung parameters like FVC, FEV1, PEFR, FEF 25%- 75%, MVV and ERV are compared between aged matched control group and women of each trimester. On comparing lung parameters between control group and women of all the trimesters, it was found that decrease in FVC is highly significant in all trimesters. Similarly, FEV1 is also found to be decreased significantly (p<0.001-Highly Significant). Peak expiratory flow rate is also decreased modestly in women of Ist trimester whereas decrease in PEFR is significantly high in second and third trimesters. It is found that FEF 25 % -75 % is also significantly reduced after Ist trimester. As far as maximum voluntary ventilation is concerned, it is decreased during pregnancy from first trimester onwards in a significant manner. It is also seen that ERV is significantly reduced in Ist trimester and as the pregnancy progresses the reduction is highly significant.

In most of the studies it was observed that, there were decline in the respiratory parameters (PEFR, ERV) suggestively due to

lesser force of contraction of main expiratory muscles like anterior abdominal muscles and internal intercostals muscles. The reduction in contraction power of expiratory muscles is due to the stretching of the abdominal wall with the progress of pregnancy.(2)

In the study of Neeraj et al, it was showed that all parameters except FEV1/ FVC ratio were found to decrease in the test group consisted of pregnant women of IIIrd trimester. (4)

Bernard J et al studied that during late pregnancy, there is a 25% reduction in FRC and about 40% reduction in ERV. Slight and statistically insignificant reductions in total lung capacity and VC were also found in their study. (5)

The study of Skandan KP et al showed a rise in Tidal Volume (TV) together with a decrease in Expiratory Reserve Volume (ERV) and Vital Capacity during pregnancy.(6)

Pande Y et al observed an inconsistent decrease in vital capacity during pregnancy & the ERV showed a significant decrease which was most pronounced in the last trimester of pregnancy. The functional residual Capacity and the residual Volume decreased progressively as pregnancy advanced.(7)

Decrease in FVC may be due to a relative decrease in the negativity of the intrapleural pressure brought about by an upward displacement of the diaphragm by the enlarging uterus. (4,8) Decrease in FEV1, FEF25-75% and PEFR may be due to a decline in alveolar Pco2 (caused by hyperventilation) which acts as bronchoconstrictor. (9) Hormone determined changes in smooth muscle tone and possibly connective tissue elastance might occur during pregnancy which would alter the mechanical properties of the respiratory system.

We found a similarity in our findings with those by Mokkapatti et al(10), Monga and kumara,(11) Puranik et al (1995) (12) and Phatak et al. (9)Some studies like Milne JA(13) showed significant rise in Forced Vital Capacity (FVC).

Thus our study shows the physiological changes, adaptations and decline in lung function parameters progressively during the course of pregnancy. So, we can advise the breathing exercises to the pregnant women and also to the postpartum exercise to improve the respiratory functions

Since the study is cross sectional and the sample size is small, future longitudinal studies need to be done with large sample size. PFT should be a part of routine antenatal check up to prevent any possible respiratory complication.

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