

Original Article

A Comparative Study of Physiological Variations in Pulmonary Function Tests during Pregnancy

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Abstract

Introduction: Pregnancy is principally a phenomenon of maternal adaptation to the increasing demands of the growing fetus. Pregnancy causes many visible and invisible changes in human body and it represents one of the best examples of selective adaptation in terms of respiratory. **Materials and Method:** The study consists of recording the Pulmonary Function Tests of 4 groups of female subjects including pregnant women of various phases of gestational period i.e., 12 weeks (I trimester), 24 weeks (II trimester), 36 weeks (III trimester) and control group of non pregnant women. The different lung function parameters measured in this study were Expiratory Reserve Volume (ERV), Tidal Volume (TV), Vital Capacity (VC), Residual Volume (RV) & Minute Ventilation(MV), PEFR – Peak Expiratory Flow Rate, FVC – Forced Vital Capacity FEV1 – Forced Expiratory Volume in one second. **Results:** We observed a statistically significant decrease in Expiratory Reserve Volume, Residual Volume and a significant increase in Tidal Volume, Minute Volume & Vital Capacity remains unchanged in different trimesters of pregnancy. **Conclusion:** From the results of our study it can be concluded that significant changes in pulmonary physiology occur during pregnancy which are necessary to meet the increased metabolic demands of the mother and fetus. The changes in Pulmonary functions are helpful in the prevention of gestational complications associated with inadequate maternal respiratory adaptation pulmonary Function Tests.

Keywords: Expiratory Reserve Volume , Tidal Volume , Vital Capacity, Peak expiratory flow rate.

Introduction

During healthy pregnancy, pulmonary function, ventilatory pattern and gas exchange are affected through both biochemical and mechanical pathways. Progesterone acts as trigger of the primary respiratory centre by increasing the sensitivity of the respiratory centre to carbon dioxide and also alters the smooth muscle tone of the airways resulting in a bronchodilator

effect. Progressive uterine distension and elevation of the diaphragm causes increase in negative pleural pressure leading to an earlier closure of the small airways with consequent reduction of functional residual capacity (FRC) and expiratory reserve volume (ERV). Secondly, the chest height becomes shorter, but transverse thoracic dimensions increase and the average subcostal angle of the ribs at the xiphoidal level increases from 68.5° at the beginning of pregnancy to 103.5° at term in order to maintain constant total lung capacity. With pregnancy progression, the resting position of the diaphragm moves 5 cm upward with the increasing uterus size. This causes its capability to generate tension increases secondary to muscle fibre lengthening; its area of opposition to the lower ribcage increases; and its radius of curvature increases, due to the progressive enlargement of the

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lower ribcage to give space to the lungs. In addition, the upward movement of the diaphragm causes FRC decrease. Following hyperventilation and reduced levels of PCO_2 , arterial oxygen tension increases, reaching 106–108 mmHg and 101–104 mmHg in the first and third trimesters, respectively. Lung volumes undergo major changes as ERV gradually decreases during the second half of pregnancy (reduction of 8–40% at term) because residual volume reduces (by 7–22%). FRC then decreases (by 9.5–25%) while inspiratory capacity increases at the same rate in order to maintain stable TLC. Pulmonary static and dynamic compliance, diffusing capacity and static lung recoil pressure do not change during pregnancy¹. Pulmonary function tests (PFTS) permit an accurate and reproducible assessment of the functional state of respiratory system and allow quantification of the severity of disease. Various investigators have studied pulmonary function tests (PFTS) during normal pregnancy but their results were conflicting². Based on these considerations, we endeavored to perform a more extensive study with repeated measures of healthy pregnant women in order to provide pertinent data on the physiological changes in lung function during pregnancy.

Material & Method

The study was conducted on pregnant and nonpregnant individuals (N=100). The case group includes pregnant women of various phases of gestation periods of 1st trimester (12 weeks), 2nd trimester (24 weeks) and 3rd trimester and on control group of non-pregnant women of child bearing age (20-35years). Case group involves 75 pregnant individuals of all the three trimesters and 25 nulliparous women of same age group were randomly selected by open invitation

Inclusion Criteria- Age group-16-30 yrs primigravida or multigravida. The criteria for selection of study were uncomplicated pregnant women, physically and mentally capable of adequate co-operation during the performance of the tests.

Exclusion Criteria- Respiratory, cardiovascular diseases or hypertension anemia, multiple pregnancy,

smoking hydramnios & those on chronic therapy for any other ailment were excluded from the study tests were performed under calm conditions with the subject in a sitting position according to American Thoracic Society (ATS) guidelines.

Recording of PFTs:

Prior to the study each subject was informed in details of its objectives and the aim of the research protocol and methods to be used. Their consent was obtained. The equipment used is Computerized data logging Spirometer for recording the pulmonary function tests (UNI-EM Spiromin 6.24.9 Ink). All the subjects were called for spirometric tracings in the afternoon between 3 to 5pm. (3-4 hrs after meal) in the post absorption stage in order to keep uniform conditions for recording the tests. When the subject was confident and familiar with the procedure, she was asked first to perform maximal inspiration after a deep expiration. The subject was 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. The tracings in the spiograph were taken after being fully satisfied. 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.

Statistical Analysis: Data were reported as mean and standard deviation (mean+SD), mean were compared between two groups by unpaired 't' test. A 'p' value of less than 0.05 was considered statistically significant. Descriptive statistical analysis was carried out in the present study. Result on continuous measurements were presented on (Mean±SD). Student 't' test was used to find the significance of study parameters between two groups

Statistical software: The statistical software SPSS 10.0 was used for the analysis of the data and Microsoft word and excel have been used to generate tables. The study was approved by the institutional ethical committee clearance.

Results

TABLE 1: Comparison of spirometric variables between nulliparous and first trimester pregnant women

P.F.T	Nonpregnant mean \pm SD	Ist Trimeter Pregnant Women	Unpaired t Value	P value
ERV	1144.80 \pm 95.44	996.00 \pm 124.10	4.752	0.0001
T.V	472.00 \pm 67.45	546.00 \pm 84.06	3.432	0.0012
R.V	1129.60 \pm 73.74	1008.00 \pm 111.50	4.548	0.0001
MV	5309.92 \pm 316.42	5967.60 \pm 335.77	7.127	0.0001
V.C	3880.00 \pm 462.17	4816.00 \pm 398.62	7.602	0.0001
PEFR	390.40 \pm 116.03	334.40 \pm 40.93	2.275	0.027
FVC	3912.00 \pm 307.03	4029.60 \pm 436.70	1.101	0.276
FEV1	2824.00 \pm 281.78	2447.20 \pm 351.18	4.184	0.0001

According to the present study as depicted in the Table.1, The mean ERV of 1st trimester pregnant women was increased compared to controlled group which was also found to be statistically significant. The mean (TV) of 1st trimester pregnancy individuals was higher than control group the difference was found to be statistically highly significant. The mean RV of 1st trimester pregnant individual was lower than mean RV of controlled group the difference was found to be statistically significant. The mean MV was found to be increased in 1st trimester pregnant women compared to controlled group which

was statistically significant. The mean VC of 1st trimester pregnant women increased compared to controlled group which statistically significant. The mean PEFR of 1st trimester pregnant individual was lower than mean PEFR of controlled group the difference was not found to be statistically significant. The mean FVC was found to be increased in 1st trimester pregnant women compared to controlled group which was statistically significant. The mean FEV1 of 1st trimester pregnant women decreased compared to controlled group which statistically significant.

TABLE 2: Comparison of spirometric variables between nulliparous and second trimester pregnant women

P.F.T	Nonpregnant mean \pm SD	2 nd Trimeter Pregnant Women	Unpaired t Value	P value
ERV	1144.80 \pm 95.44	975.20 \pm 96.79	6.2385	0.0001
T.V	472.00 \pm 67.45	604.00 \pm 87.70	5.965	0.0001
R.V	1129.60 \pm 73.74	1004.00 \pm 101.98	4.990	0.0001
MV	5309.92 \pm 316.42	6008.33 \pm 369.39	7.117	0.0001
V.C	3880.00 \pm 462.17	4704.00 \pm 457.78	6.272	0.0001
PEFR	390.40 \pm 116.03	314.80 \pm 59.52	2.898	0.005
FVC	3912.00 \pm 307.03	3480.00 \pm 518.81	3.582	0.008
FEV1	2824.00 \pm 281.78	2584.00 \pm 420.00	2.37	0.02

According to the present study as depicted in the Table 2, The mean ERV of 1st trimester pregnant women was increased compared to controlled group which was also found to be statistically significant. The mean (TV) of 1st trimester pregnancy individuals was higher than control group the difference was found to be statistically highly significant. The mean RV of 1st trimester pregnant individual was lower than mean RV of controlled group the difference was found to be statistically significant. The mean MV was found to be increased in 1st trimester pregnant women compared to controlled group which

was statistically significant. The mean VC of 1st trimester pregnant women increased compared to controlled group which statistically significant.

The mean PEFR of 1st trimester pregnant individual was lower than mean PEFR in controlled group the difference was found to be statistically significant. The mean FVC was found to be increased in 1st trimester pregnant women compared to controlled group which was statistically significant. The mean FEV1 of 1st trimester pregnant women decreased compared to controlled group which statistically significant.

TABLE 3: Comparison of spirometric variables between nulliparous and third trimester pregnant women

P.F.T	Nonpregnant mean \pm SD	3rd Trimester Pregnant Women	Unpaired t Value	P value
ERV	1144.80 \pm 95.44	868.00 \pm 85.24	10.815	0.0001
T.V	472.00 \pm 67.45	652.40 \pm 58.11	10.13	0.0001
R.V	1129.60 \pm 73.74	909.20 \pm 59.58	11.624	0.0001
MV	5309.92 \pm 316.42	5817.60 \pm 503.53	4.268	0.0001
V.C	3880.00 \pm 462.17	5208.33 \pm 776.79	7.265	0.0001
PEFR	390.40 \pm 116.03	206.40 \pm 90.69	6.247	0.0001
FVC	3912.00 \pm 307.03	3480.00 \pm 518.81	3.582	0.008
FEV1	2824.00 \pm 281.78	2453.76 \pm 371.01	3.97	0.0002

According to the present study as depicted in the Table.1, The mean ERV of 1st trimester pregnant women was increased compared to controlled group which was also found to be statistically significant. The mean (TV) of 1st trimester pregnancy individuals was higher than control group the difference was found to be statistically highly significant. The mean RV of 1st trimester pregnant individual was lower than mean RV of controlled group the difference was found to be statistically significant. The mean MV was found to be increased in 1st trimester pregnant women compared to controlled group which was statistically significant. The mean VC of 1st trimester pregnant women increased compared to controlled group which is statistically significant.

The mean PEFR of 1st trimester pregnant individual was lower than mean PEFR of controlled group the difference was found to be statistically significant. The

mean FVC was found to be increased in 1st trimester pregnant women compared to controlled group which was statistically significant. The mean FEV1 of 1st trimester pregnant women decreased compared to controlled group which is statistically significant.

Discussion

In our study the pulmonary para-meters were found to be statistically significant. Our findings confirmed that increase in TV compared with non-pregnant individuals was highly significant and also decrease RV, ERV was highly significant in all the trimesters of pregnant women compared with non-pregnant women and found results were coincides the findings of dudhamal, shailaja,et. Al^{3,4,5}. Increase in MV andVC in all trimesters of pregnant women are compared to non-pregnant individuals was also statistically significant and our findings are found to be same as that ofSroczyński

T, Chhbraa S et al^{6,7}. Decrease in PEFr, FVC, FEV1 in all trimesters of pregnancy were found to be statistically significant when compared with non pregnant women and our findings are found to be same as that of Sunyal DK et. al.^{8,2,9,10}

Conclusion

The present study concluded there is gradually fall in all pulmonary function tests values. The enlarging uterus, alter the resting position of diaphragm. It is important for clinician to be aware of the normal physiological changes in pregnancy. FEV1, FVC decrease in pregnant case group providing that pregnancy is a restrictive condition and not obstructive condition. Understanding these changes are critical in distinguishing common dyspnea that occurring during pregnancy from physiological state associated with cardiopulmonary disease seen in pregnancy. By means of continuous antenatal surveillance disease can be identified early and its deterioration can be prevented by proper management. The accurate information of the respiratory status of the pregnant individual to the clinician, obstetrician anaesthetist to help in managing respiratory complications of the pregnancy.

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