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Study of FEV1, VC and PEFR in different trimesters of pregnancy

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Abstract:

Background & Objectives: The aim of the present study was to monitor the changes that occur in pulmonary function tests in the different trimesters of pregnancy as compared with that of control group i.e., non pregnant women. **Materials & Methods:** The study consists of recording the Pulmonary Function Tests of four groups of female subjects including pregnant women of various phases of gestational period i.e., 12 weeks, 24 weeks 36 weeks and control group of non pregnant women using computerized Medspiror. The different static lung function parameters measured in this study were vital Capacity (VC), FEV_1 and Peak Expiratory Flow Rate (PEFR). PEFR was measured with Mini Wright's peak flow meter. **Results:** We observed a statistically significant decrease in PEFR ($p < 0.0001$), a significant increase in VC & no significant change FEV_1 in different trimesters of pregnancy. **Conclusion:** Comparative study of pulmonary function tests on different trimesters of pregnancy showed that different respiratory parameters like PEFR were compromised significantly due to mechanical pressure of gravid uterus, diaphragm restricting the movement of lungs. VC showed a significant increase in different trimester's when compared with the non pregnant state whereas FEV1 showed no significant change. The respiratory system undergoes physiological and anatomical changes during pregnancy and we observed a significant decrease in PEFR and increase in VC among pregnant women.

Key words: Forced Expiratory Volume in 1st sec (FEV1); Peak Expiratory Flow Rate (PEFR); Pregnancy; Spirometry; Vital Capacity (VC)

Introduction

Marked local and systemic changes in maternal physiology are initiated by conception and they continue throughout the pregnancy. Pulmonary function is affected by changes of the airway, thoracic cage and respiratory drive. There is a significant increase in minute ventilation as a result of a direct stimulatory effect of progesterone on central respiratory drive and an enhancement of the hypercapnic ventilatory drive. Lung compliance does

not change, but total respiratory compliance is decreased at term as a result of a reduction in chest wall compliance. Despite the significant increase in intra-abdominal pressure that is due to the enlarging uterus, the maximal inspiratory and expiratory pressures, as well as maximum trans-diaphragmatic pressure do not change significantly. In pregnancy, the hormonal changes along with progressive increase in abdominal volume may have mechanical impact on respiratory function. However, an increased transverse diameter of the chest, resulting from a widened sub costal angle, opposes the effect of the enlarging pregnant uterus and elevated diaphragm, maintaining an altered pulmonary function during pregnancy [1].

There is no significant change in respiratory muscle strength during pregnancy despite the cephalad displacement of the diaphragm and changes in the configuration of the chest wall. Despite the upward displacement of the diaphragm by the gravid uterus, diaphragm excursion actually increases by 2 cm when compared with the non pregnant state [2,3]. Increased diaphragmatic excursion and preserved respiratory muscle strength are important adaptations, given the increase in tidal volume and minute ventilation that accompanies pregnancy. Improved diaphragm mechanics in pregnancy are explained by an increased area of apposition of the diaphragm to the rib cage [3].

Routine spirometric measurements {forced expiratory volume in 1 second - FEV1} and FEV1/ FVC ratio are not significantly different compared with non pregnant values. VC has been reported to be either minimally increased, decreased, or unchanged during pregnancy compared with the non pregnant state; on average, there is no significant change in VC in most of the studies [4-7]. The stability of spirometry during pregnancy suggests that there is no significant change in expiratory airflow resistance with pregnancy. Hormone determined changes in smooth muscle tone and elastance of the connective tissue which occur during pregnancy could possibly alter the mechanical properties of the respiratory system. The increase in progesterone and estrogen associated with pregnancy contribute to vascular and central nervous system effects, changes in the balance of bronchoconstrictor and bronchodilator prostanoids and increase in peptide hormones which alter connective tissue characteristics.

The values obtained by forced spirometry, including forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), and peak expiratory flow rate (PEFR) have largely been found to remain unchanged during pregnancy [8-10]. In other studies, PEFR is found to decrease with advancing gestational age and to be affected by maternal positioning [11-12] and by living at high altitude [13].

Materials and Methods

The study consists of recording the Pulmonary Function Tests of four groups of female subjects including both normal and pregnant women of various phases of gestational period i.e., 12 weeks, 24 weeks & 36 weeks and control group of non pregnant women of the child bearing age. The subjects considered for this study are with Hemoglobin more than 10 gm%. The study was approved by the Institutional Ethical Committee.

All the subjects were called for spirometric tracings in the afternoon between 3 to 5pm. (3 to 4 hrs after meal) in the post absorption stage in order to keep uniform conditions for recording the tests. All the subjects are given instructions and demonstration with regard to performance of the tests. The tracings in the spirograph were taken after being fully satisfied that the subject has understood the procedure of the test. Two to three tracings were taken out of which the best is taken as final reading.

The female subjects who are nonsmokers and free from cardiovascular and respiratory ailments were grouped into four groups as: Group 1 - Female normal subjects aged 20-25 years; Group 2 -Pregnant subjects of first trimester gestational period aged 20-25 years ; Group 3- Pregnant subjects of second trimester gestational period aged 20-25 years ; Group 4 - Pregnant subjects of third trimester gestational period of age 20-25 years .The different lung function parameters measured in this study include FEV_1, VC & PEFR. PEFR was measured with the Mini Wrights peak flow meter. Statistical Analysis was done using Graphpad prism 6 software and unpaired t test was done to estimate the p value between different groups.

Results

The mean Vital Capacity in I trimester subjects showed a marginal increase of 3.48% when compared with the control non pregnant subjects ($p = 0.0116$). Similarly , the mean VC in II & III trimester subjects showed an increase of 3.68 % & 6.51% respectively (p value = 0.0155; $p < 0.0001$ respectively) when compared with the control subjects.

Table 1: Comparison of Mean Values of PEFR, FEV1 & VC along with p value in different trimesters of pregnancy

	CONTROL MEAN±SD	1ST TRIMESTER MEAN±SD	P VALUE
PEFR	5.904 ± 0.02970	5.645 ± 0.02284	P < 0.0001 ****
FEV1	1.582 ± 0.02698	1.598 ± 0.01748	P= 0.6122
VC	3.011 ± 0.02022	3.116 ± 0.03434	P = 0.0116 *

	CONTROL MEAN±SD	2ND TRIMESTER MEAN±SD	P VALUE
PEFR	5.904 ± 0.02970	5.430 ± 0.01611	P < 0.0001 ****
FEV1	1.582 ± 0.02698	1.603 ± 0.02839	P= 0.5838
VC	3.011 ± 0.02022	3.122 ± 0.03923	P= 0.0155 *

	CONTROL MEAN±SD	3RD TRIMESTER MEAN±SD	P VALUE
PEFR	5.904 ± 0.02970	5.160 ± 0.01633	P < 0.0001 ****
FEV1	1.582 ± 0.02698	1.604 ± 0.03112	P = 0.5897
VC	3.011 ± 0.02022	3.207 ± 0.03687	P < 0.0001 ****

Significant increase in VC seen in III trimester subjects when compared with control subjects is much more when compared with the increase in VC seen in I & II trimester subjects.

The mean PEFR in I trimester subjects showed a significant decrease of 4.39% when compared with the control non pregnant subjects (p value < 0.0001). Similarly, the mean PEFR in II & III trimester subjects also showed a significant decrease of 8.03% & 12.60% respectively when compared with the control subjects (p < 0.0001 & p< 0.0001 respectively). Statistically significant decrease in PEFR was seen in all the trimesters of pregnancy i.e., I, II & III trimester subjects when compared with control subjects and the decrease was much more in III trimester subjects when compared with the decrease in PEFR seen in I & II trimester subjects.

The mean FEV_1 in I trimester subjects showed a non significant increase of 1.01% when compared with the control non pregnant subjects (p value = 0.6122). Similarly, the mean FEV_1 in II & III trimester subjects showed a non significant increase of 1.33% & 1.52 % respectively when compared with the control subjects (p = 0.5838 & p = 0.5897 respectively). No significant change was observed in FEV1 in different trimesters of pregnancy.

Discussion

In our study Forced Expiratory Volume in one second (FEV1) did not show any significant change in I, II & III trimester's of normal pregnant women as compared to non pregnant women except PEFR which showed a significant decrease in different trimesters of pregnancy. Regarding Vital Capacity, some of the studies [12,14-15] showed a

decrease in FVC and few other studies [10] showed a significant increase in VC. In our study we observed a significant increase in VC.

No change in FEV1 was observed in few studies [14,16] . The results of our study correlate with the findings of the above studies regarding FEV_1. Berry M J et al [17] found that during pregnancy, no change in Vital Capacity (VC) was observed. Also concluded that no change occur in FEV1/FVC% and Forced Expiratory Volume in 1st second i.e., FEV1%. The inspiratory Capacity was increased during pregnancy, due to the altered thoracic configuration and also due to heightened sensitivity to the nervous stimuli required to produce muscular contraction. Also a decline in the Expiratory Reserve Volume and a persistent increase in Tidal Volume (VT) were observed.

Significant decrease in FEV_1, FVC and FEV_1/FVC was found in all the three trimesters of pregnancy in a study conducted by Shazia Batool et al [18]. Highly significant decline in FVC, FEV1, FEV3, MVV and PEFR in all the trimesters of pregnancy as compared to control was observed in a study by Sushma Jadhav et al [19].

No change in Vital Capacity, Peak Expiratory Flow Rate or Forced Expiratory Volume in one second in pregnancy was observed by Nelson Piercy C [20]. Also observed that normal pregnancy is associated with a 20% increase in oxygen consumption and a 15% increase in the maternal metabolic rate and this extra demand is achieved via 5 % increase in Resting Minute Ventilation, resulting from a rise in Tidal Volume rather than respiratory rate leading to hyperventilation. No change in Vital Capacity was observed in other studies conducted [21].

Decrease in FEV_1during pregnancy was seen in many studies [15,22-24] but we found a non significant increase in FEV_1, significant increase in FVC. Puranik BM et al [22] conducted a longitudinal study on pulmonary function tests during pregnancy and they concluded that the Vital Capacity remained unchanged throughout pregnancy and no change was observed in FVC, FEV1 which correlates with the findings of our study. Also decline in PEFR which was observed in this study correlates with our study. Mrunal SP et al [23] studied about the antenatal changes in lung function tests and importance of postpartum exercises in their recovery. They concluded that the change in FVC and FEV_1 % were insignificant, but they observed a significant decline in Expiratory Reserve Volume and PEFR and the increment in Inspiratory Capacity was also significant. The decline in PEFR observed in our study is in accordance with this study.

Pande Y et al [25] observed that the inconsistent decrease in vital capacity in some of the subjects during pregnancy was in accordance with the observation of earlier investigators who found it to be either unchanged or slightly decreased during pregnancy. The Forced Expiratory Volume in the first second (FEV_1) and Maximum Mid Expiratory Flow Rate (MMFR) were increased. Kaltreider NL et al [26] observed that during pregnancy, oxygen consumption and Minute Ventilation consistently increased and there was individual variation both in direction and magnitude of the change in Vital Capacity. The FEV1/VC remained unaltered. The Expiratory Reserve Volume (ERV) and Functional Residual Capacity (FRC) were decreased progressively. They also found that the Residual Volume (RV) was also progressively decreased. A decrease in FVC, FEV1 & PEFR in pregnancy was observed by Neeraj Candy S et al [27] and our study do not correlate with this study. A non significant increase in FEV1 and significant increase in VC and a decrease in PEFR are observed in our study.

Decline in PEFR during the third trimester of pregnancy as observed by Hemant Deshpande et al [28] correlates with our study. In fact, we observed a gradual decline in PEFR in different trimesters of pregnancy. The results of our study were in contradictory to the study of Weerasekara DS et al [29] who observed that there is no significant change in VC & PEFR in pregnancy.

Grindheim G et al [30] conducted a longitudinal study to observe the changes in pregnancy and evaluate the influence of parity, pre-gestational overweight and excessive weight gain on lung function. They observed that the FVC & FVC% increased after first trimester of pregnancy. Also found that VC, FVC%, PEFR and PEF% in early and mid-pregnancy were significantly lower compared with the postpartum value.

Knox AJ et al [31] observed a number of physiological changes which occurred during pregnancy. No significant change in peak flow rates, forced vital capacity or forced expiratory volume in the first second (FEV1) is observed. The decline in PEFR in the first trimester can be attributed to morning sickness, lack of nutrition whereas in second and third trimester it may be due to mechanical pressure of enlarging gravid uterus, Elevation of the diaphragm and restrictive movements of lungs. PEFR is more sensitive to muscular element in respiration and as anemia

produces muscle weakness, it reflects in lowering the PEFR (Singhal et al) [32].

Sunyal DK et al [33] studied about the Peak expiratory flow rate in pregnant women in Bangladesh. They observed that the Peak expiratory flow rate and their percentage of predicted values were significantly lower during third trimester of pregnancy compared to controls and it progressively decreased from first to third trimester. PEFR in our study also showed a similar decrease in different trimesters of pregnancy. The decline in PEFR during pregnancy occurs suggestively due to lesser force of contraction of main expiratory muscles like anterior abdominal muscles and internal intercostal muscles [34-35] .The results of most studies done on western populations indicate that vital capacity and peak expiratory flow rate do not change significantly throughout the course of pregnancy.

Conclusion

Comparative study of pulmonary function tests in different trimesters of pregnancy showed a decrease in PEFR significantly which may be due to mechanical pressure of gravid uterus, diaphragm restricting the movement of lungs especially in third trimester of pregnancy. There was a decrease in respiratory parameters like PEFR from first to third trimesters of pregnancy which may also be due to poor nutrition. To establish the precise cause of decrease in different lung function parameters, further studies are to be undertaken like hormonal assay in different trimesters to study the effect of hormones on different lung function parameters. Continuous Monitoring of lung function in different trimesters provide adequate information regarding maternal healthcare. Obstructive / restrictive lung disorders during pregnancy can be identified early which can be prevented by proper management. Pregnant women need regular monitoring of lung function by spirometry in order to optimize their lung function throughout pregnancy.

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