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Original Research Article

Assessment of Forced Vital Capacity and Peak Expiratory Flow Rate and its Association with Progesterone Level in Pregnancy: Hospital Based Observational Study

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Abstract

Aim: This study was conducted to assess FVC and PEFR and to correlate with Progesterone levels in different trimesters of pregnancy.

Material & Methods: The present observational study was carried out in the department of Physiology, PMCH, Patna, Bihar. Total of 100 subjects were taken for the study. The subjects were taken from the department of Obstetrics & Gynaecology OPD from Patna medical college and Hospital, Patna, Bihar, India. These subjects were divided into four study groups. Each group consist of 25 subjects.

Results: In the present study, weight and BMI showed significant difference in anthropometric measurements. Decrease in FVC in 1st ($p<0.000$), 2nd ($p<0.000$) and 3rd ($p<0.000$) trimesters of pregnancy when compared to control group was significant. In between the three trimesters there was no significant decrease ($p> 0.05$) in FVC values. There was significant and positive correlation of FVC and progesterone in the first and third trimester of pregnancy. Decrease in PEFR levels in 1st ($p<0.000$), 2nd ($p<0.000$) and 3rd ($p<0.000$) trimesters of pregnancy was significant when compared to control group. Amongst the three trimesters there was significant decrease ($p<0.001$) in third trimester when compared to 1st and 2nd trimester. There was significant and positive correlation with the progesterone in the first trimester of pregnancy. There was a positive correlation in all 3 trimesters of pregnancy and significant in 1st and 3rd trimester.

Conclusion: The progesterone levels did not have any significant association with the pulmonary function test during gestation.

Keywords: Pregnancy, Forced Vital Capacity (FVC), Peak Expiratory Flow Rate (PEER), Progesterone.

Introduction

Pregnancy marks numerous alterations in the physiological, biochemical, and anatomical profiles that involves multiple organ system & is also associated with various changes in pulmonary anatomy and physiology. The major anatomical changes associated with thorax during pregnancy are expansion of circumference of lower thorax, upward movement of diaphragm, and 50% increase in costal angle. [1,2,3] The physiological changes occurring in a pregnant woman are vast and widespread. These include changes in genital organs, an increase in breast size, weight gain, and other systemic alterations including respiratory, cardiovascular, body water metabolism, haematological, and metabolic changes. [4] Alteration in thoracic cage, respiratory drive, and airway affects pulmonary function. These adaptations are necessary to meet the increased metabolic demands of the mother and the fetus. The combination of hormonal changes and mechanical effects of the enlarging uterus leads to a change in the pulmonary physiology of a mother. [5,6]

Biochemical variations are increased in prostaglandins, estrogen, progesterone, cyclic nucleotide, and corticosteroids that accompany pregnancy. Hormone-induced changes in elastance of the connective tissue and smooth muscle tone may result in mechanical modulation of the respiratory system. [7] An upward movement of the diaphragm in the later stages of pregnancy is an indication of the pressure developed by the uterus on the abdomen, mitigating negative intrapleural pressure and hyperventilation with a decrease in the partial pressure of carbon dioxide. [8,9] Transverse diameter of the chest increases due to the expanded subcostal angle that resists the effect of expanding the uterus and the upward movement of diaphragm to provide change in the pulmonary function as required for the pregnancy. [10] Progressively enlarging uterus causes a diaphragm position to rise approximately 4 cm above its usual resting position that favours the lung to hold less air. As a result, lung volumes are compromised including functional residual capacity (FRC), total lung capacity (TLC), and vital capacity (VC). [7,8] Dynamic pulmonary function tests like FVC, FEV1, FEV1%, and FEF25-75% also decrease due to the gravid state of advanced pregnancy. [6,11]

The pulmonary function test (PFT) provides information about the different types of pulmonary diseases, lung capacities, pre- and post-treatment differences, and severity of the disease. Computerized spirometry has an advantage over manual spirometer, as it presents with general information about the patients and spirogram (graphical representation of volume-time curve). [12]

The alterations in respiratory physiology have been attributed to Progesterone, which was thought to increase ventilation by increasing respiratory center sensitivity to carbon dioxide as a result the tidal volume and minute ventilation is increased. [13]

This study was done to evaluate the pulmonary function parameters using spirometry in primigravidae, and to correlate with their progesterone levels.

Material & Methods

The present observational study was carried out in the department of Physiology, PMCH, Patna, Bihar. Hundred subjects were taken for the study. The subjects were from the Obstetrics and Gynaecology OPD, Patna medical college and Hospital, Patna, Bihar, India. Duration of study was one & half year (July 2021 to December 2022). All subjects were selected randomly. Out of 100 subjects 75 were pregnant primigravidae, selected from Antenatal clinic and 25 nulliparous women were selected from family

planning OPD of Obstetrics Dept, Patna medical college and Hospital, Patna, Bihar, India.

These subjects were divided into 4 study groups. Each group consists of 25 subjects.

Group 1: contains 25 Non-pregnant women (control group)

Group 2: contains 25 Primigravidae in 1st trimester,

Group 3: contains 25 Primigravidae in 2nd trimester,

Group 4 – contains 25 Primigravidae in 3rd trimester.

Subjects of group 2, 3 and 4 were test groups.

Inclusion Criteria

Healthy normal Primigravidae in the age group 18 to 25 years and nulliparous women in the same age group. All pregnant females had haemoglobin above 10 gm%. All subjects were selected from the dept. of obstetrics & Gynae. Patna medical college and hospital, Patna, Bihar.

Exclusion Criteria:

The subjects refused to participate in the study were not included.

Subjects with Chronic respiratory illness, Hypertension, Diabetes mellitus, Pregnancy induced hypertension, Endocrine disorders, Acute and chronic CVS diseases, multiple pregnancies were not selected.

All nulliparous women with irregular menstruation, smokers, obese, individual with RTI, individuals with H/O medication-oral contraceptive pills, bronchodilators, anti-tubercular drugs were not selected for the study.

Methodology

All the subjects had written consent for participation in the study and ethical clearance was taken.

Examination performa used for recording the clinical examination findings was clinically well designed and validated. Digital Spirometer was used for recording the pulmonary function tests and the make was (RMS- Helios spirometer).

They were assessed during morning hours (9am to 12 noon). The preliminary clinical and respiratory system examination was done. Vital parameters and anthropometric measurements (height & weight) were taken. BMI was calculated.

Preparation before spirometry

- subjects were advised to wear loose clothing.

-15 mins rest was allowed before test.

-avoid eating/drinking for at least 1 hr before test.

-all the subjects were given necessary instructions & demonstration before the test.

During the test procedure they were encouraged and guided properly.

Patients details were filled first. Then FVC and PEFR was recorded using spirometer.

Blood sample was collected and Progesterone assay was done using chemiluminescence immunoassay (CLIA).

Statistical Analysis:

Comparisons were performed using unpaired student's t-test for 2 group comparisons and one-way Anova was employed for multiple groups. Versi SPSS 21 was used for analysis. The p value of 0.05 or less was depicted as significant. Pearson's correlation method was used to correlate.

Results

Table 1: Comparison of anthropometric measurements

Parameters	Control	1st Trimester	2nd Trimester	3rd Trimester
	Mean± SD	Mean± SD	Mean± SD	Mean± SD
Age in years	22.8 ± 1.62	23 ± 2.4	24 ± 3	22 ± 1.8
Height in cm	156.4 ± 4.6	156.1 ± 3.2	157.5 ± 5.5	158 ± 5.2
Weight in Kgs	52.08 ± 6.4	54.6 ± 3.7	60.4 ± 8.2	68 ± 2
BMI (Kg/m2)	22.05 ± 2.8	22.4 ± 1.75	24.6 ± 3.07	26.4 ± 2.56

In the present study, weight and BMI showed significant difference in anthropometric measurements.

Table 2: Comparison of pulmonary function parameters

Parameters	Control	1st Trimester		2nd Trimester		3rd Trimester	
	Mean± SD	Mean± SD	P value	Mean± SD	P value	Mean± SD	P value
FVC (% predicted)	96.94 ±8.02	84 ±16	0.000	88.92 ± 6.34	0.0	87.3 ±15.30	0.0004
PEFR (% predicted)	72.83 ± 4.87	55.45 ±11.60	0.000	54.6 ± 8.42	0.0	52.8 ± 5.70	0.0000
Progesterone	16.24 ±8.02	36 ±8.02	0.000	52.88 ±8.48	0.0	70.6 ± 8.42	0.0000

Decrease in FVC in 1st ($p<0.000$), 2nd ($p<0.000$) and 3rd ($p<0.000$) trimesters of pregnancy when compared to control group was significant. In between the three trimesters there was no significant decrease ($p> 0.05$) in FVC values. There was significant and positive correlation of FVC and progesterone in the first and third trimester of pregnancy. Decrease in PEFR levels in 1st ($p<0.000$), 2nd ($p<0.000$) and 3rd ($p<0.000$) trimesters of pregnancy was significant when compared to control group. Amongst the three trimesters there was significant decrease ($p<0.001$) in third trimester when compared to 1st and 2nd trimester. There was significant and positive correlation with the progesterone in the first trimester of pregnancy.

Table 3: Comparison of pulmonary function parameters

Parameters	1st & 2nd Trimester P Value	2nd & 3rd Trimester P Value	1st & 3rd Trimester P Value
FVC (% predicted)	0.180	0.840	0.420
PEFR (% predicted)	0.025	0.000	0.003
Progesterone	0.0001	0.0001	0.0001

There was a positive correlation in all 3 trimesters of pregnancy and significant in 1st and 3rd trimester.

Discussion

Pregnancy causes physiological and anatomical changes in different body systems. [14-16] The physiological changes occurring in a pregnant woman are vast and widespread. These include changes in genital organs, an increase in breast size, weight gain, and other systemic alterations including respiratory, cardiovascular, body water metabolism, haematological, and metabolic changes. [17] These adaptations are necessary to

meet the increased metabolic demands of the mother and the fetus. Besides the size of the gravid uterus, many of the physiological changes in the respiratory system are mediated by increased progesterone levels.[18] Progesterone is a known stimulant of breathing, and its level in the blood gradually rises approximately from 25 ng/mL at six weeks of gestation to 150 ng/mL at term. [19,20] This progressive increment is responsible for the raised respiratory depth and rate. [21,22] Progesterone increases tidal volume by 200mL (from 500mL to 700mL) and minute- ventilation approximately by 40%. This is by increasing the sensitivity of the respiratory center to carbon dioxide. Progesterone-mediated hypersensitivity to CO2 increases the respiratory rate by 10% which attributes to the raised oxygen consumption during pregnancy.

In the present study, weight and BMI showed significant difference in anthropometric measurements. Decrease in FVC in 1st ($p<0.000$), 2nd ($p<0.000$) and 3rd ($p<0.000$) trimesters of pregnancy when compared to control group was significant. In between the three trimesters there was no significant decrease ($p> 0.05$) in FVC values. There was significant and positive correlation of FVC and progesterone in the first and third trimester of pregnancy. Decrease in PEFR levels in 1st ($p<0.000$), 2nd ($p<0.000$) and 3rd ($p<0.000$) trimesters of pregnancy was significant when compared to control group. Amongst the three trimesters there was significant decrease ($p<0.001$) in third trimester when compared to 1st and 2nd trimester. There was significant and positive correlation with the progesterone in the first trimester of pregnancy. There was a positive correlation in all 3 trimesters of pregnancy and significant in 1st and 3rd trimester. Sunyal DK et al., attributed that there was decrease in PEFR in all trimesters of pregnancy which was significant in second and third trimesters of pregnancy. Progressively reduced value of PEFR in three trimesters of pregnancy may be attributed to the mechanical effects of enlarged gravid uterus reducing vertical dimension by limiting movement of diaphragm. [23] In addition some degree of obstruction to the expiratory flow, especially late in pregnancy also must have contributed.

In this study the significant decrease in FVC and PEFR could be due to the mechanic al pressure of enlarging uterus which elevates the diaphragm and thus restricting the movements of lungs during forceful expiration. Decrease in PEFR also could be due to lesser force of contraction of main expiratory muscles like the anterior abdominal wall muscles and internal intercostal muscles. There was gradual increase in progesterone levels in all three trimesters. This also indirectly stimulates the secretion of endogenous catecholamines thereby through sympathomimetic action causes Broncho dilatation. Though there is enlargement of uterus, progesterone effect tries to balance the restrictive changes in pregnancy.

Conclusion

This study gives information that there is a definite alteration in pulmonary parameters during different trimesters of pregnancy. The same study involving larger population would help us more in deriving the norms on predicted values on pulmonary parameters in pregnancy. The present study concluded that pregnancy at altitude can bring about compensatory changes to balance with the changes occurring in dynamic pulmonary function tests. However, longitudinal studies may reveal better results with larger sample sizes; therefore, future studies need to be done with large sample size and longitudinal studies taking parity, chest size, type of pregnancy, and other socioeconomic factors into consideration.

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