

Comparison of both static and dynamic pulmonary function test parameters in Indian pregnant and non-pregnant women

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Abstract

Introduction: Pregnancy is a physiological stressful condition accompanied by an increased cellular activity to fulfill the requirement of rapidly developing embryo & subsequent fetal growth. Hence, it was proposed to estimate the degree of alteration in pulmonary function during pregnancy in South Indian population.

Materials and Method: Uncomplicated singleton pregnancies in 1st, 2nd & 3rd trimesters (n=10 in each group) along with healthy parous non pregnant age matched control (n=10) were included in this study. Pulmonary function tests were carried out in subjects using computerized spirometer & finally data were collected. Results were analysed by ANOVA taking $p < 0.05$ as statistically significant.

Results: Present study showed significant increase in inspiratory reserve volume (IRV), inspiratory capacity (IC) & vital capacity (VC) in pregnant women as compared to controls. But expiratory reserve volume (ERV) & peak expiratory flow rate (PEFR) were decreased significantly in study group. On the other hand, tidal volume (TV) & FEV₁/FVC ratio were not significantly altered between pregnant & non-pregnant women.

Conclusion: In view of these observations it can be concluded that pregnancy leads to physiological alteration in the lung function parameters of a woman as a consequence of mechanical as well as complex hormonal factors which are reversible but not compromised as such due to progressive distension of gravid uterus.

Keywords: Pulmonary function test, Vital capacity, Pregnancy, Spirometry

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Introduction

Pregnancy is an important phase in every woman's life during which there is profound anatomical, physiological & biochemical adaptations so that her body can adjust itself to the parasitic growth of the fetus. Changes in respiratory physiology are a part of the same process. Assessment of Pulmonary Function during different trimesters of pregnancy has proved to be useful not only for early detection of these changes but also subsequent follow-up for necessary intervention to ensure safe perinatal outcome. Previous studies have demonstrated marked alteration in respiratory functions of pregnant Indian women from their Western counterparts particularly increase in vital capacity, tidal volume & inspiratory capacity whereas steady decline in Peak Expiratory Flow Rate from 3rd to 9th month gestation was observed.^(1,2,3,4)

These changes occur gradually in a sequential manner throughout the antenatal period so that the nutritional status of the growing fetus is properly regulated. Most of the above studies have been performed mainly in Western population, only few reports have been found done in Indian women so far. These are conflicting & inconclusive in most instances. Moreover serial evaluation of lung function parameters during different trimesters of pregnancy have not been evaluated so far. Therefore this study is designed to estimate the pulmonary function changes during

different trimesters of pregnancy for comparison in healthy South Indian women. The aim of the project was to study pulmonary function alteration during pregnancy and to compare with non-pregnant women. It was hypothesized that pregnant women are more prone to pulmonary function alteration particularly during late 2nd & early part of 3rd trimester of pregnancy.

Materials and Method

This was an observational study involving human subjects only. The study was conducted in the Department of Physiology of a tertiary care centre at Pondicherry. The study protocol was approved by the institutional ethical committee. The study group consisted of thirty healthy pregnant women in the age group of 18-25 years in 1st, 2nd & 3rd trimesters of pregnancy respectively (10 in each group) coming for antenatal check up to the Obstetrics & Gynecology Department of this institution. While ten age matched, healthy, non-pregnant, parous women served as controls. Detailed medical as well as obstetric histories regarding the present & previous pregnancies were obtained from each participant. The participants did not have a history of respiratory or any cardiovascular illness. None of them were taking any medication except vitamins, iron & calcium supplement. There was no history of smoking/alcohol/drug abuse. Pregnancy with diabetes, hypertension and with multiple pregnancies were

excluded from this study. An informed written consent was obtained from all the participants after explaining the experimental protocol in detail in their native language.

The subjects were first brought to the Clinical Physiology laboratory from Obstetrics & Gynaecology OPD. The Pulmonary Function Tests were carried out using the computerized spirometer (Koko Legend Ferraris respiratory, version II A, Louisville, USA) using the standard laboratory methods. The spirometer was calibrated regularly. The questionnaire was filled up & relevant data (name, age, sex, height, weight) was entered in the computer. The study was conducted between 9-11 AM to avoid diurnal variation. The ambiance of the environment particularly the laboratory temperature was maintained at 25°C during the procedure. The test module was activated and the subject was given proper instruction about the procedure to be performed. All the Pulmonary Function Tests were done on the subjects in standing posture under the guidance of the principal investigator. The subject was asked to breathe in & breathe out through the disposable mouthpiece with a nose clip applied during the maneuver to familiarize her with the equipment and the procedure. During the test the subject was adequately encouraged to perform at their optimum level. Tests were repeated three times with intervals of 5 minutes rest in between each performance. The best results were finally considered for analysis.

Descriptive statistics were expressed as mean and standard deviation. Comparison of various parameters were done between 1st, 2nd & 3rd trimesters of pregnancy and also with control using one way analysis of variance (ANOVA) followed by post hoc analysis statistical test. The statistical procedures in this study were performed

by using Graphpad InStat software version 3. Difference with a p value < 0.05 was considered to be statistically significant.

Results

The general parameters of study group were age 22.6 ± 2.228 years, height 154.07 ± 5.21 cms, weight 56.5 ± 12.02 kg while that of controls were age 24.73 ± 0.65 years, height 152.36 ± 6.22 cms, and weight 51.27 ± 8.20 kg. The values of lung function parameters were compared in between all four groups.

Effect of Pulmonary function test in different trimesters of pregnancy: Table 1 shows comparison of pulmonary function test values between non-pregnant and pregnant women of various trimesters. In present study, Inspiratory reserve volume (IRV) was higher in all trimesters of pregnancy as compared to controls which was statistically significant ($p < 0.05$). Inspiratory capacity (IC) was also higher in all the trimesters of pregnancy. However, the statistically significant difference was found between women in 1st and 3rd trimester pregnancy ($p < 0.05$) with controls. Vital capacity (VC) was also higher in all the trimesters of pregnancy. However, statistically significant difference was observed between 1st trimester of pregnancy alone and non-pregnant controls ($p < 0.05$).

Expiratory reserve volume (ERV) values were lower in all the trimesters of pregnancy. But statistically significant difference was seen between women in 1st and 3rd trimester pregnancy ($p < 0.01$) with controls. Peak expiratory flow rate (PEFR) values were lower in all the trimesters of pregnancy as compared to non-pregnant women which was statistically significant ($p < 0.05$).

But tidal volume (TV) values were not significantly different between pregnant & non-pregnant women. Similarly FEV₁/FVC ratio were found to be less in pregnant women when compared to controls but did not reach statistical significance. (Table 2)

Table 1: Pulmonary function test in different trimesters of pregnancy compared with non-pregnant women

	IRV (L)	VC (L)	ERV (L)	PEFR (L/s)	IC (L)
Control	1.74 ± 0.27	2.83 ± 0.34	0.97 ± 0.13	4.45 ± 1.92	2.15 ± 0.32
1 st trim	2.32 ± 0.38*	3.23 ± 0.32*	0.74 ± 0.20*	2.55 ± 0.93*	2.89 ± 0.39*
2 nd trim	2.19 ± 0.40*	3.00 ± 0.33	0.84 ± 0.12	2.24 ± 0.84*	2.70 ± 0.41
3 rd trim	2.32 ± 0.30*	3.14 ± 0.25	0.73 ± 0.13*	2.45 ± 1.25*	2.78 ± 0.26*
Anova P value	0.001	0.030	0.002	0.001	0.002

All values are expressed as Mean ± SD.

Analysis was done using ANOVA with post hoc test.

*Significance with control ($p < 0.05$)

IRV: Inspiratory Reserve volume; VC: Vital Capacity; ERV: Expiratory Reserve volume;

PEFR: Peak Expiratory Flow Rate. IC: Inspiratory capacity

Table 2: Pulmonary function test in different trimesters of pregnancy compared with non-pregnant women

	TV (L)	FEV ₁ /FVC
Control	0.44 ± 0.10	0.93 ± 0.09
1 st trim	0.57 ± 0.15	0.85 ± 0.19
2 nd trim	0.51 ± 0.13	0.86 ± 0.10
3 rd trim	0.46 ± 0.07	0.88 ± 0.11
Anova P value	0.059	0.490

All values are expressed as Mean \pm SD.

Analysis was done using ANOVA with post hoc test.

TV: Tidal volume; FEV1/FVC: Forced expiratory volume in 1st second / Forced vital Capacity.

Discussion

In the present study IRV, IC & VC were found to be significantly higher in pregnancy than controls which were consistent with previous studies.^(3,5,6,7,8) Respiratory system undergoes mechanical and chemical adaptations during pregnancy to increase ventilatory drive significantly. The mechanical effect is due to the increase in the uterine volume and the elevation of the diaphragm. The chemical adaptation relates to the stimulatory effects of female sex hormones (progesterone and estrogen) on central and peripheral chemoreceptor reflex mechanism which leads to increased chemosensitivity of the CO₂ on respiratory centres. Both are responsible for significant increase in IRV during pregnancy.^(9,10,11)

On the other hand ERV was found to be decreased significantly in study group which was also shown by previous workers.^(3,5,6,7,8) One possible cause may be that the cephalic displacement of the diaphragm by enlarged uterus decreases negativity of intrapleural pressure thereby reducing the expiratory reserve volume.⁽¹¹⁾ Another important cause for the decline is reduction in contraction power of expiratory muscles due to progressive stretching of the abdominal wall as pregnancy advances.⁽⁸⁾

But tidal volume (TV) did not reach statistical significance between pregnant & non-pregnant women which was shown by previous workers.^(3,5,6,7,8) This observation might suggest that sedentary life style has got a negative influence on pulmonary function which is modified by lung dimension, compliance and respiratory muscle power. Lung function parameters in an apparently healthy population could also be influenced by atmospheric pollution, socio-economic & nutritional status.

Present study could not demonstrate any significant difference in FEV1/FVC ratio between the groups, This was similar with previous observations which showed that there is no change in timed vital capacity parameters from 1st trimester till term, which suggests that normal pregnancy does not induce any alteration in large airway function.^(5,12,13,14,15)

During pregnancy, progesterone, corticosteroids and relax in all together cause bronchomotor tone reduction and smooth muscle relaxation.⁽¹⁵⁾ Respiratory muscle function remains normal despite the alteration of thoracic configuration.⁽¹⁶⁾ Thus the mechanical disadvantage to the respiratory apparatus induced by advancing pregnancy is compensated by decrease in airway resistance and an improved airway conductance.⁽⁷⁾

On the other hand in the present study peak expiratory flow rate (PEFR) declined significantly in study group. This was similar with previous report which

stated that decrease in PEFR was due to lesser force of contraction of main expiratory muscles like anterior abdominal muscles and internal intercostal muscles.⁽⁷⁾ Another study has also demonstrated that PEFR declined significantly throughout gestation in all maternal positions with advancing gestational age, but more in the supine position. Therefore adjustment of patient's flow rate in relation to gestational age and maternal position was recommended, especially in pregnant women with asthma.⁽¹⁷⁾

Limitation

Present study was conducted within a stipulated time period of 2 months only involving a small number of subjects which was insufficient to alter the physiology of lung function parameters of pregnancy. Also because of the limitation in time factor it was not possible to undertake serial evaluation of all pulmonary function test parameters in the same pregnant woman from beginning of first trimester throughout pregnancy till delivery unlike all previous studies which was pertaining to almost 1 year duration. Moreover only age matched parous healthy women were taken here as control but in other studies control was chosen selectively from postpartum group.

Conclusion

Pregnancy has important effects on pulmonary functional parameters in each trimester. But the susceptibility to such alterations are variable. The pulmonary status of women during pregnancy are not only modulated by hormonal changes but also by external factors such as racial, genetic background, nutritional as well as socio-economic status which may lead to intense response in some women but not in others. Though the pulmonary physiology is definitely altered but not compromised as such in normal pregnant women. Presence of any concomitant disease condition might aggravate these alterations leading to development of systemic manifestations. Therefore a detailed & prospective study in future to evaluate the pulmonary status during pregnancy will help us not only to understand the basic mechanism underlying it but also to extend proper antenatal care to susceptible individuals to ensure maternal & fetal well-being.

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