Research Article

A comparative study of dynamic pulmonary function tests in Indian pregnant and nonpregnant women

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Abstract

Background: Pregnancy is a state of adaptation in terms of maternal physiology for fulfilling the increasing requirements of developing fetus and pulmonary function tests (PFTs) are a powerful tool in assessing the changes in respiratory functions associated with it.

Objective: To compare the dynamic PFTs in the third trimesters of pregnancy (study group) with the matched nonpregnant women (control group) in Indian population.

Materials and Methods: In this study 65 subjects from a tertiary care hospital of Mumbai who volunteer for the study were divided into two groups consisting of 35 pregnant women (study group) with with 30 age and height matched non-pregnant women (control group). PFTs were done by computerized spirometry.

Result: Statistical analysis was carried out and unpaired *t*-test was applied. The difference in mean values of FEV_1/FVC%, PEFR, FEF 25, FEF 50, FEF 75, and FEF 25-75 in normal pregnant women in their third trimester when compared with matched normal nonpregnant women were not statistically significant.

Conclusion: This study highlights the observations that though PFT parameters changes during pregnancy but the maternal respiratory functions overall remains unaffected. The fetal well-being is thus ensured with adaptive changes in maternal respiratory physiology during pregnancy. This knowledge of pulmonary function changes may be helpful in the evaluation of PFT readings in pregnancy.

KEY WORDS: Pulmonary function tests, pregnancy, peak expiratory flow rate (PEFR), forced expiratory flow (FEF)

Introduction

Pregnancy is a state of adaptation in terms of maternal physiology for fulfilling the increasing requirements of developing fetus especially in view of prime importance of O_2 supply from mother in all the trimesters of pregnancy. Maternal physiology undergoes many adaptive changes and the respiratory system forms an important part of it.[1] These adaptive changes are all aimed at the well-being of the growing fetus.

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Common respiratory disorders encountered and complicating pregnancy are asthma, tuberculosis, cystic fibrosis, pneumonia, pneumothorax including some serious conditions such as pulmonary embolism and adult respiratory distress syndrome. Pulmonary function tests (PFTs) are one of the powerful tools for evaluation of respiratory disorders in pregnancy and due to availability of advanced instruments such as computerized spirometer, evaluation of pulmonary functions has become easy and accurate. The different forms of PFTs available include static and dynamic of which, on one hand, static tests are more correlated to body weight, height, and body surface area with a relatively low relationship with fitness and on the other hand, dynamic tests usually have a higher relationship with fitness variables rather than body size variables and are also helpful in evaluation of lung diseases.

Dynamic PFTs thus are an important tool in the evaluation of the functional as well as fitness state of the respiratory system and also for the assessment of severity of illness. This knowledge aids the physician to accurately interpret the adaptive changes in the respiratory system in pregnant women and thus preventing any unnecessary treatment for the physiologically changed respiratory functions misinterpreted as being abnormal while comparing the same with before pregnancy values.[2] This information about the expected physiological changes in pulmonary function is essential in understanding the interrelationship between pulmonary diseases and pregnancy.[3] Functional status of respiratory system of pregnant women is also important in evaluation for anesthetic fitness.[4]

Earlier studies evaluating PFTs in normal pregnant women have shown conflicting results.[5–9] Previous studies documented changes in PFTs during pregnancy but evaluation of dynamic tests parameters specifically in third trimester remains an area of research. For the management of any respiratory disorder complicating pregnancy, correct interpretation of normal adaptive changes in pulmonary functions during pregnancy is essential. This gave us an impetus to study dynamic PFTs specifically in the third trimester of uncomplicated pregnancy and to compare them with those of matched nonpregnant women and establishing norms of adaptive changes in respiratory physiology during pregnancy in the Indian population.

Materials and Methods

The study was undertaken in the Department of Physiology in association with the Department of Gynaecology and Obstetrics, in a well-known tertiary care hospital in Mumbai. Institutional Ethics Committee clearance was obtained prior to the study. A total of 35 pregnant women of 20–30 years of age in their third trimester of normal pregnancy (study group) and 30 nonpregnant women (control group) volunteered for the study. The study group were from middle socioeconomic status who came for their regular antenatal visit in the hospital. The age, height, and socioeconomically matched volunteers in the control group were relatives accompanying the pregnant women and also among the students and hospital staff who volunteer for this study.

All the participants were included in the study after their informed written consent, detailed history, and a complete clinical examination. Participants having any known respiratory or cardiovascular diseases, multiple pregnancy, anemia, hydramnios, or those on treatment for any other disease were excluded from the study. The age, height (in cm), and weight (in kg) of the subjects and room temperature (in °C) were noted on the day of assessment of the tests. Computerized flexiflow machine with pneumotachograph was used to perform the dynamic PFTs.

Before recording the PFT, the procedure was explained and demonstrated in detail till proper understanding. Doubts, if any was answered to their satisfaction and instructions about the importance of nose clip and maintaining a tight seal with the lips around the mouth piece while preforming the tests was given. Comfort of each participant was ensured during the procedure of recording the PFTs. A trial was then given after which three satisfactory attempts were recorded and results determined from the best efforts. Full cooperation was sought and the subjects were urged to make maximum effort. During the performance of test, subjects were closely monitored to detect leakage of air, if any.

Recording of PFTs

Each subject was asked to sit comfortably in a chair facing the computerized flexiflow machine. Subject's age, sex, height, weight, and specific room temperature were entered in the computer. The subject was asked to properly secure the nose clip and a new clean disposable mouth piece was used which was attached to the breathing tube. Subjects took a few tidal breaths after which they were instructed to take a maximum deep inspiration followed by a maximum forceful expiration. Two curves were plotted, one was the flow volume curve in which the volume in litres was plotted on the *X*-axis and the flow of air in L/s was plotted on the *Y*-axis. The second curve was the time–volume curve in which the time in seconds was plotted on the *X*-axis and the volume in litres was plotted on the *Y*-axis.

The following volumes, capacities, and flow rates were computed in the study and control groups:

1. Forced vital capacity (FVC): This is the volume of air that can be exhaled by a maximum forceful expiration after maximum inspiration. It is expressed in litres.
2. Forced expiratory volume 1 (FEV_1): It is a fraction of FVC exhaled at the end of first second. It is expressed in litres.
3. FEV_1/FVC%: This is the ratio of the volume of air expired at the end of the first second of a maximum forceful expiration after maximum inspiration, to the total volume of air expired during the entire forceful expiration. $FEV_1\% = FEV_1/FVC \times 100$
4. Peak expiratory flow rate (PEFR): This is the maximum flow rate that can be sustained for a period of 10 ms by maximum forceful expiration following maximum inspiration. It is expressed in L/s.
5. Forced expiratory flow 25-75 (FEF 25-75): This is the mean rate of expiratory flow between 25% and 75% of expired FVC. It is expressed in L/s.
6. Forced expiratory flow 25 (FEF 25): This is the instantaneous flow rate at the point when 25% of FVC has been exhaled. It is expressed in L/s.
7. Forced expiratory flow 50 (FEF 50): This is the instantaneous flow rate at the point when 50% of FVC has been exhaled. It is expressed in L/s.
8. Forced expiratory flow 75 (FEF 75): This is the instantaneous flow rate at the point when 75% of FVC has been exhaled. It is expressed in L/s.

The actual values, predicted values, and the percentage of predicted values of each parameter were recorded. Data were compiled in Excel spread sheet and the level of significance was tested by unpaired *t*-test. The *p*-value less than 0.05 indicates that results are significant statistically and *p*-value less than 0.01 indicate that the results are highly significant statistically.

Result

Table 1 shows that study and control group had very similar physical characteristics and statistical difference between the two groups was not significant. The only notable difference was that, while one group of women was pregnant, the other group of women was nonpregnant. Table 2 shows that the difference in mean values of forced vital capacity (FVC), forced expiratory volume at the end of first second (FEV_1), and FEV_1/FVC% in pregnant and non-pregnant women was not significant statistically ($p > 0.05$).

Table 3 shows that the difference in mean values of PEFR, forced expiratory flow between 25% and 75% of FVC (FEF 25–75) in pregnant and nonpregnant women was not significant statistically ($p > 0.05$). Table 4 shows that the difference in mean values of forced expiratory flow at 25% of FVC (FEF 25), forced expiratory flow at 50% of FVC (FEF 50), forced expiratory flow at 75% of FVC (FEF 75) in pregnant and nonpregnant women was not significant statistically ($p > 0.05$).

Discussion

Dynamic PFTs, timed vital capacity measurements and the measurements of PEFR, mean flow rate between 25% and 75% of FVC, instantaneous flow rates at 25%, 50%, and 75%

Table 1: Physical characteristics of the pregnant and nonpregnant women. Values are expressed as mean ± standard deviation (SD)

Parameters	Study group Pregnant (*N* = 35)		Control group Nonpregnant (*N* = 30)	
	Mean	SD	Mean	SD
Age (years)	24.60	± 2.91	25.23	± 2.43
Height (cms)	156.37	± 4.56	154.53	± 5.06
Weight (kgs)	51.90	± 6.34	51.60	± 6.34
Body surface area (sqm)	149.85	± 9.92	148.03	± 9.58

Table 2: Standard deviation, mean, and difference in mean values of forced vital capacity (FVC), forced expiratory volume at the end of first second (FEV1) and FEV1/FVC% in pregnant and nonpregnant women

Parameters	Mean ± Standard Deviation		Difference between both groups	Percentage change	Significant/ nonsignificant
	Pregnant	Nonpregnant			
FVC (Litres)	2.531 ± 0.28	2.461 ± 0.33	+ 0.070	+ 2.84	Nonsignificant ($p > 0.05$)
FEV_1 (Litres)	2.331 ± 0.25	2.203 ± 0.29	+ 0.128	+ 5.90	Nonsignificant ($p > 0.05$)
FEV_1/FVC (%)	92.09 ± 1.03	89.51 ± 1.01	+ 2.58	+ 2.88	Nonsignificant ($p > 0.05$)

Note: "+" denotes mean reading is more and "-" denotes that the mean reading is less in the two groups.

Table 3: Standard deviation, mean, and difference in mean values of peak expiratory flow rate (PEFR) and mean forced expiratory flow between 25% and 75% of forced vital capacity (FEF 25-75) in pregnant and nonpregnant women

Parameters	Mean ± Standard Deviation		Difference between both groups	Percentage change	Significant/ nonsignificant
	Pregnant	Nonpregnant			
PEFR (L/s)	457.11 ± 80.65	441.90 ± 92.54	+ 15.21	+ 3.44	Nonsignificant ($p > 0.05$)
FEF 25–75 (L/s)	330.30 ± 49.33	304.67 ± 65.54	+ 25.36	+ 8.32	Nonsignificant ($p > 0.05$)

Note: "+" denotes mean reading is more and "-" denotes that the mean reading is less in the two groups.

Table 4: Standard deviation, mean, and difference in mean values of forced expiratory flow at 25% of FVC (FEF 25), forced expiratory flow at 50% of FVC (FEF 50), forced expiratory flow at 75% of FVC (FEF 75) in pregnant and nonpregnant women

Parameters	Mean ± Standard Deviation		Difference between both groups	Percentage change	Significant/ nonsignificant
	Pregnant	Nonpregnant			
FEF 25 (L/s)	437.62 ± 85.88	426.83 ± 94.07	+ 10.79	+ 2.52	Nonsignificant ($p > 0.05$)
FEF 50 (L/s)	365.57 ± 51.71	347.80 ± 71.78	+ 17.77	+ 5.11	Nonsignificant ($p > 0.05$)
FEF 75 (L/s)	216.48 ± 50.98	191.79 ± 55.91	+ 24.68	+ 12.86	Nonsignificant ($p > 0.05$)

Note: "+" denotes mean reading is more and "-" denotes that the mean reading is less in the two groups.

of expired FVC do not show any significant change in pregnancy as compared to the nonpregnant state. Thus all dynamic PFTs results of the two groups as compared to each other were unaltered. Theses parameters remained unchanged in pregnancy inspite of a change in factors that can affect them which includes anatomical, hormonal, and biochemical effects. Enlargement of gravid uterus may cause restrictive effect. Reported reduction in alveolar partial pressure of carbondioxide in pregnancy[10,11] is associated with bronchial smooth muscle constriction and can cause obstruction in airway function.[12] Low partial pressure of carbondioxide has been shown to have direct effect on smooth muscle causing constriction in bronchial muscle strips.[13] Also increased airway angulation at the lung base as occurs in pregnancy can alter airway function. Airway resistance is dependent on lung volume, a reduction in the latter causing an increase in the former.[14] Increased intrapulmonary blood volume as occurs in pregnancy would also tend to reduce airway caliber and increase resistance.[15] However, in this study, flow rates remained unaltered in the pregnant women when compared with nonpregnant women. All these observations can be explained on the basis that these factors have a negligible influence in increasing flow resistance and reducing conductance[16] or alternatively humoral factors affect transbronchial smooth muscle tone[17] and protect pulmonary function throughout pregnancy. Progesterone, corticosteroids, and relaxin have been implicated in bringing about a reduction in resistance and increase in conduction in the respiratory passage due to reduced bronchomotor tone and smooth muscle relaxation.[18] Thus, it is likely that unaltered airway function in pregnancy may be due to a balance between those factors tending to increase airway resistance and those tending to decrease it. The unfavorable structural alterations in maternal respiratory system caused by advancing pregnancy is thus well-counteracted by adaptive physiological compensatory changes.[19]

Limitations of the Study

Studies on larger population are required to be undertaken so as to set a standard reference range of the PFT values in the three trimesters of pregnancy. Such norms would aid in accurate evaluation of the changes in maternal respiratory function by treating physicians during management of pulmonary complications in pregnancy.

Conclusion

During last few decades PFTs evolved as an important tool in assessing respiratory status. This study highlights the observation that though PFTs parameters change during pregnancy, it is not unfavorable in terms of any functional disadvantage to the respiratory system. The efficiency of maternal respiratory physiology is thus not impaired, as adaptive changes in respiratory system compensate for the altered structure and function of the maternal body and very well suffice for the increased needs of pregnancy.

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