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Research Article

A comparative study of static pulmonary function tests in Indian pregnant and non-pregnant women

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ABSTRACT

Background: Pregnancy represents one of the best examples of selective adaptation in terms of respiratory physiology. Objective of the study is to evaluate the changes in static pulmonary function tests (PFTs) in third trimesters of pregnancy (study group) and compare with non-pregnant women (control group).
Methods: 65 subjects (study group 35 subjects and control group 30 subjects) from a tertiary care hospital of Mumbai were included in the study. Pulmonary function tests (PFTs) was done by computerized spirometry.
Results: Statistical analysis was carried out and paired t-test was applied. Significant increase in mean inspiratory capacity and significant decrease in mean expiratory reserve volume were observed in the third trimester of normal pregnant women as compared to normal non-pregnant women.
Conclusions: The present study highlights observation that there is no respiratory impairment due to pregnancy, 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.

Keywords: Pulmonary function tests, Pregnancy, Third trimester of pregnancy

INTRODUCTION

Death is an inevitable end of life. For perpetuation of species, reproduction is thus essential. Reproductive life in women is more protracted and dynamic than in men. Pregnancy constitutes an additional alteration in the women's reproductive life. During the course of pregnancy, the fetus gradually grows and therefore, brings about generalized systemic changes in the mother to accommodate and adapt to the needs of developing fetus. Anatomical, physiological and biochemical adaptations that occur during pregnancy and profound changes in respiratory physiology are a part of the same process.[1] Pregnancy represents one of the best examples of selective adaptation in terms of respiratory physiology.

Static pulmonary function tests permit an accurate and reproducible assessment of the functional state of the respiratory system and allow quantification of the severity of disease. Its precise knowledge allows the clinician to verify the extent of the adaptation in pregnant women and helps to avoid unnecessary treatment of physiological changes misinterpreted as pathological in reference to pre-pregnancy standards.[2] This knowledge of the expected or desired changes in pulmonary parameters is fundamental to understanding of how the disease states affect pregnancy and vice versa.[3] Understanding of the maternal pulmonary function adjustments helps to avoid inappropriate diagnosis and unnecessary intervention. Information regarding status of pulmonary function is also essential for assessment of fitness for anaesthesia.[4]

Various investigators have studied pulmonary function tests during normal pregnancy but their results were conflicting.[5-9] Although there are reports of changes in pulmonary function tests during pregnancy, not much work has been done specifically in third trimester. The above observations gave us an impetus to study the changes in static pulmonary function tests in third trimester of uncomplicated pregnancy as compare with matched non-pregnant women and to establish norms of adaptive changes in respiratory physiology.

METHODS

The study was conducted in the Department of Physiology in collaboration with Department of Obstetrics and Gynaecology, in a well-known tertiary care hospital in Mumbai. Clearance from the Institutional Ethical Committee was obtained prior to the study. The study included 35 pregnant women in their third trimester of uncomplicated pregnancy (study group) and 30 non-pregnant women (control group). The 35 pregnant women of 20-30 years age group who volunteered for the present study were belonging to middle socio economic status and came for regular check-up in the hospital on OPD basis. The age matched controls were volunteers from the relatives of pregnant women who were attending the OPD and from amongst the hospital staff and students. Those with known respiratory or cardiovascular diseases, anaemia, multiple pregnancy, hydramnios or those on chronic therapy for any other ailment were excluded from the study.

After taking informed written consent from each subject, a detailed history was recorded and a complete clinical examination was done to rule out the exclusion criteria. The age, height (in cm) and weight (in kg) of the subject and room temperature (in °C) was noted on the day of assessment of the tests. Computerized Flexiflow machine with pneumotachograph was used to perform the static pulmonary function tests (PFT).

Prior to performing the PFT, the procedure was thoroughly explained as well as demonstrated to each subject, the queries and apprehensions of the subjects were satisfied emphasizing the need to maintain an effective seal with lips around the mouth piece as also the use of nose clip during the procedure. Each subject was made to relax for minimum 5 minutes prior to performing the PFT procedure. A trial was then given after which three satisfactory attempts were recorded and results determined from the best efforts. Full co-operation 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.

The following parameters were recorded in the study and control group:

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 liters.
2. Inspiratory Capacity (IC): This is the volume of air that can be breathed in by maximum inspiration following a normal tidal expiration. It is expressed in liters.
3. Expiratory Reserve Volume (ERV): It is the volume of air that can be breathed out by maximum expiration over and above the normal tidal expiration. It is expressed in liters.

Recording of PFTs

Each subject was asked to sit comfortably in a chair facing the computerized flexiflow machine. Information regarding the age, sex, weight, height of the subject and specific room temperature was fed into the computer. A nose clip was secured properly to the nose and a new clean disposable mouth piece was attached to the breathing tube for each subject. The subject was asked to perform maximal inspiration with maximal effort. Mouthpiece was placed in the mouth and then was asked to perform maximum expiration into the mouthpiece with maximum effort. This records the Forced Vital Capacity (FVC). Then the subjects were asked to breathe in by maximum inspiration following a normal expiration. This records the Inspiratory Capacity (IC). Lastly to record Expiratory Reserve Volume (ERV), the subject was asked to breathe out by a maximum expiration over and above the normal expiration. The readings of the actual, predicted and percentage of predicted values for each parameter was recorded. Data was compiled using Microsoft Office Excel software and the level of significance was tested by unpaired t-test. The p-value less than 0.05 indicate that the results are significant statistically and p-value less than 0.01 indicate that the results are highly significant statistically.

RESULTS

Table 1 show that the study and control group had very similar physical characteristics with no statistically significant difference between the two groups and the only notable difference was that, while one group of women was pregnant, the other group of women was non-pregnant.

Table 1: Physical characteristics of the study group and the control group.

Parameters	Study group pregnant (N=35)		Control group non-Pregnant (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

Values are expressed as Mean ± Standard Deviation (SD)

Table 2 shows the mean values and standard deviation of Forced vital capacity (FVC), Inspiratory Capacity (IC) and Expiratory Reserve Volume (ERV) observed in the study and control groups.

Table 2: Mean values and standard deviation of forced vital capacity (FVC), Inspiratory Capacity (IC) and Expiratory Reserve Volume (ERV) in the study group and the control group.

Parameters	Study group pregnant (N=35)	Control group non-Pregnant (N=30)
Forced vital capacity (FVC)	2.531 ± 0.28	2.461 ± 0.33
Inspiratory capacity (IC)	1.768 ± 0.31	1.578 ± 0.29
Expiratory reserve volume (ERV)	0.757 ± 0.16	0.878 ± 0.22

Values are expressed as Mean ± Standard Deviation (SD)

Table 3 shows that the difference of means of Forced vital capacity (FVC) was non-significant ($p > 0.05$) and the difference of means of Inspiratory Capacity (IC) and Expiratory Reserve Volume (ERV) was significant statistically ($p < 0.05$).

Table 3: Difference in mean values of forced vital capacity (FVC), inspiratory capacity (IC) and expiratory reserve volume (ERV) in the study group and the control group.

Para-meters	Difference between pregnant and non-pregnant group	Perce-ntage change	Significant/ non-significant
Forced Vital Capacity (FVC)	+ 0.070	+ 2.84	Non-Significant ($p > 0.05$)
Inspiratory Capacity (IC)	+ 0.189	+ 11.99	Significant ($p < 0.05$)
Expiratory Reserve Volume (ERV)	– 0.121	– 13.78	Significant ($p < 0.05$)

"+" denotes the mean reading is more and "–" denotes mean reading is less in the two groups

DISCUSSION

In the present study inspiratory capacity is more and expiratory reserve volume is less in pregnant women as compared to non-pregnant women which is statistically significant and thus these opposite changes keep vital capacity unchanged in pregnancy. These observations can be explained by the altered thoracic configuration and respiratory mechanics during pregnancy. The uterus progressively enlarges with advancing pregnancy which elevates the diaphragm and its position can be as much as 4 cm above the non-pregnant level.[10] This would reduce the vertical diameter of the thorax and reduce its volume. The thoracic volume however is not affected because the lost volume due to the reduction of vertical diameter is compensated for by the increase in anterior-posterior diameter and transverse diameter of the thoracic cage. This occurs due to the flaring of the lower ribs and widening of the sub costal angle. These mechanical changes due to the enlarging uterus and distending abdomen are aided by hormones. Relaxin increases the mobility of joints and helps in achieving these changes.[11]

The sub costal angle has been shown to increase from an average of 68.5 degree in the first trimester of pregnancy to 103.5 degree at term. This widening of the sub costal angle and flaring of lower ribs has been shown to enlarge the circumference of the thoracic cage by upto 5 to 7 cms.[12] These changes keep vital capacity unchanged and aid in augmenting the inspiratory capacity during pregnancy. During pregnancy, other than the widening of the sub costal angle and flaring of lower ribs, it is also known that the relative mobility of thoracic cage increases. More mobility in the sternomanubrial joints during pregnancy as compared to purperium has been pointed out.[12] This has been ascribed to the action of hormone Relaxin. Increased thoracic mobility aids the augmentation of inspiratory capacity and helps in maintaining vital capacity.

Inspiratory capacity is increased in pregnancy due to the increased excursion of diaphragm. It is known that in pregnancy, though elevated, dynamic motion of the diaphragm is unimpaired. It has been shown that during pregnancy, respiratory movements of the diaphragm were greater than in postpartum.[13] These structural and functional changes thus explained the findings of the increased inspiratory capacity and the maintained vital capacity during pregnancy.

The significant reduction in expiratory reserve volume (ERV) during pregnancy can be explained due to the elevated diaphragm. The diaphragm during quite breathing in advance pregnancy comes to rest at a higher position than in the non-pregnant state. This would reduce the expiratory reserve volume and functional residual capacity, however this does not completely explains the contrasting changes in inspiratory capacity and expiratory reserve volume, which together keeps vital capacity unchanged. ERV reduction may be related also to inverse changes of function residual capacity and rib cage circumference in pregnancy. Part of rib cage circumferential enlargement in pregnancy may be due to accumulation of fluid or fat. Enlargement of thoracic circumference thus does not necessarily lead to an increase in lung volume, a condition seen while changing position from upright to supine.[14] Resting thoracic gas volume may be reduced also by the increase blood volume in pregnancy which acts as a space occupying lesion. ERV may also reduce due to the increased area of diaphragmatic in opposition to the lower ribs.[14] Reduced ERV in pregnancy would result also from reduction in the power of the muscles of expiration. This has been ascribed to be due to the stretching of the abdominal wall with advancing pregnancy.[15]

Limitations of the study

To establish norms on predicted and desired PFT values in various phases of pregnancy, extensive studies on larger population need to be done for evaluating PFT readings in pregnancy for accurate information of the respiratory status of the patient to the clinicians, obstetricians and the anaesthetists managing complications in the last trimester of pregnancy.

CONCLUSIONS

This study suggest that the changes taking place in pulmonary function with advancing pregnancy are an increase in inspiratory capacity and a decrease in expiratory reserve volume, while there is no change in forced vital capacity and airways function. Thus there is no respiratory impairment due to pregnancy, 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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