Research Article

Study of pulmonary function test in different trimester of pregnancy

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Abstract

Introduction: Pregnancy is characterized by sequence of dynamic physiological changes that impact on multiple organ system functions and is associated with various changes in pulmonary anatomy and physiology. The aim of the study was to see whether any changes occur in pulmonary function tests in the three trimesters of pregnancy as compared with that of' control group. **Material & Methods**: A case control study of the pulmonary function tests were carried out in different trimester of pregnancy, on 70 normal pregnant women from 16 to 30 years attending antenatal clinic at Govt. Medical College, Nanded. Four respiratory parameters FVC, FEV1, FEV3, MVV & PEFR were determined in both, 70 pregnant women as cases & control group of 30 non-pregnant women of same age groups, Using computerized Medspiror instrument. **Results**: Expiratory Reserve Volume (ERV) and mean residual Volume (RV) in the pregnant subjects as the pregnancy advances reaching its maximum decrease by the end of III trimester. Mean Tidal Volume progressively increased as pregnancy advances reaching its maximum value at term , there is a gradual increase in the mean Minute Volume (MV) of the pregnant subjects as they proceed to term when compared with the controls. The mean Vital Capacity (VC) of the subjects in the I trimester pregnancy showed a non significant increase of 3.48 % The same parameter relating to the subjects in the II and III trimester pregnancy showed a statistically significant increase of 3.50 % and 8.60% respectively as compared with control subjects. **Conclusion:** Comparative study of pulmonary function tests on different trimesters of pregnancy showed that respiratory parameters were significantly compromised during pregnancy, There were decrease in respiratory parameters from first to third trimesters of pregnancy may be due to poor nutrition because all the subjects coming from middle class and poor socio-economic status

Keywords- Pregnancy, Pulmonary Function Tests, Third trimester

Introduction

In pregnancy profound alterations in the functioning of all the systems metabolic, digestive, renal, endocrine, behavioral and cardiopulmonary system of the mother occur to accommodate the needs of the developing fetus [1]. Pregnancy is associated with significant changes in respiratory functions even in healthy women [2]. Multiple biochemical alterations like increase in progesterone, estrogen, prostaglandins, corticosteroid and cyclic nucleotide levels occur concomitantly during the course of pregnancy, additionally, capillary engorgement throughout the respiratory tract results in mucosal edema and hyperemia [3].

The effect of air pollution includes breathing and respiratory problems, aggravations of existing respiratory and cardiovascular diseases, alterations in the body defense system against foreign materials and damage to lung tissue and carcinogenesis [3,4].Prolonged exposure to dust can results in chronic bronchial problems [5]. Investigations of the respiratory health effects due to exposure to vehicular pollution exposures are necessary in order to predict the risk factors that may cause asthmatic response [6]. The timing of exposure and the specific components of air pollution that possibly impact fetal development and birth outcome preterm birth and low birth weight mostly with high levels of carbon monoxide and particulate matter during the first trimester and the final months before birth [7].

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A humoral factor alters the tracheobronchial smooth muscle tone so that pulmonary function is protected throughout pregnancy. Progesterone elevated in pregnancy influence the smooth muscle tone [1]. During pregnancy, Progesterone, Corticosteroids and Relaxin cause certain degree of brochodilatation due to relaxation of smooth muscle. Thus the mechanical disadvantage to the respiratory apparatus induced by advancing pregnancy is compensated by decrease in air way resistance and an improved air way conductance [8,9].

Material and Methods

The present study was a prospective case control study conducted in the antenatal clinic at Tertiary care teaching hospital 70 pregnant women as cases & control group of 30 non-pregnant women of same age groups were studied.

Inclusion Criteria- Age group- 16-30 yrs
Primigravida or multigravida

Exclusion Criteria- respiratory or cardiovascular diseases, anaemia, multiple pregnancy, hydramnios & those on chronic therapy for any other ailment were excluded from the study

Collection of Data-After taking informed written consent from each subject, a detailed history was recorded and complete clinical examination was done to rule out the exclusion criteria. The height as well as weight of the subject was noted as also the room temperature on the day of assessment of pulmonary function tests (PFT). The equipment used for PFT was Medspiror. Prior to performing the PFT, the procedure was thoroughly explained 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. The different lung function parameters measured in this study include ERV, IRV,TV, VC,RV and MV. Statistical Analysis was done using Graph pad prism 6 Software. Unpaired t test was used to compare the mean value's.

Recording of PFTs: The relaxed subject, in a standing position, was prepared to grip the sterile mouth piece as demonstrated to her prior to the recording. When the subject was confident and familiar with the procedure, she was asked first to perform maximal inspiration after a deep expiration. The subject was then instructed to expire with maximal effort (maximal expiration). The mouth piece was then removed and the actual, predicted and percentage of predicted values were printed for analysis. Each subject (Test or Control), was asked to repeat the maximum forced expiratory effort three times, each time with adequate rest in between, and the best reading of the three was considered for analysis.

Statistical Analysis: Statistical analysis was done by calculation of range, median, mean, standard deviation, percentage, odds ratio, chi square test and p value.

Statistical software: The statistical software SPSS 10.0 was used for the analysis of the data and Microsoft word and excel have been used to generate graphs, tables etc.

Result

The Pulmonary function tests were carried out in 70 normal pregnant women attending Antenatal Clinic at Government Medical College, Nanded. Out of 70 pregnant women, 16 were of 1st trimester, 22 were of IInd trimester and 32 were of IIIrd trimester. The aim of the study was to see whether any changes occur in pulmonary function tests in the 3 trimesters of pregnancy. The pregnant ladies were from age group of 16 to 30 years. 30 non-pregnant women of same age group were taken as control group. The readings were compared of 1st & IInd trimester, IInd & IIIrd trimester and 1st & IIrd trimester. Following observations were noted.

Table No. 1: Shows, mean age, weight and height in all three trimesters and the control.

	Age (Years)	**Weight (Kg)**	**Height (Cms)**
I Trimester	23.33±3.4	42 ± 4.56	150 ± 2.9
II Trimester	25 ± 4.55	47 ± 4.7	151 ± 2.68
III Trimester	23.8 ± 3.43	49.5 ±8.1	149. ± 2.8
Control	23 + 3.5	49 + 5.8	154 + 3.5

The above table shows, mean age was 23.33±3.4, 25 ± 4.55, 23.8 ± 3.43 in I,II,III trimester respectively and the mean weight was 42 ± 4.56, 47 ± 4.7, 49.5 ±8.1 in I,II,III trimester respectively and the mean height was 150 ± 2.9, 151 ± 2.68, 149. ± 2.8 in I,II,III trimester respectively.

Table No 2: Comparison of Mean value's of different lung function parameters between control and I trimester pregnant women

	Control Mean±Sd	Ist Trimester Mean±Sd	P- Value
ERV in litres	0.8620 ± 0.008660	0.8336 ± 0.003964	0.0055 **
TV in Litres	0.4232 ± 0.003450	0.4546 ± 0.003535	< 0.0001
VC L/min	4.011 ± 0.02022	4.116 ± 0.03434	0.0116
RV in Litres	2.120 ± 0.009420	1.9624 ± 0.01882	< 0.0001
MV Litres/min	7.224 ± 0.03842	7.345 ± 0.05149	0.0653

Expiratory Reserve Volume (ERV) of the subjects in the I trimester pregnancy, a non significant decrease of2.87% is observed in subjects of I trimester subjects (p value = 0.045). The mean Tidal volume showed statistically significant increase of 8.52 % (p value <0.0001). The mean Residual Volume (RV) showed a statistically significant decrease of 20.4% when compared to the mean Residual Volume (RV) of the controls (p<0.0001). A non significant increase of 1.844 % in the mean Minute Volume (MV) is noticed (p = 0.0653). The mean Vital Capacity (VC) of the subjects in the showed a non significant increase of 3.48 % when compared with the mean Vital Capacity (VC) of the control subjects (p value= 0.0116).

Table No. 3- Comparison of Mean values of different lung function parameters between control and II trimester pregnant women

	Control Mean±Sd	Second Trimester Mean±Sd	P Value
ERV in litres	0.8620 ± 0.008660	0.7062 ± 0.004381	< 0.0005
TV in Litres	0.4232 ± 0.003450	0.4885 ± 0.004890	< 0.0005
VC L/min	4.011 ± 0.02022	4.122 ± 0.03923	0.0145
RV in Litres	2.120 ± 0.009420	1.9495 ± 0.008944	< 0.0001
MV Litres/min	7.224 ± 0.03842	7.558 ± 0.08005	< 0.0001

The mean Expiratory Reserve Volume (ERV) in the II trimester subjects has shown a statistically significant decrease of 8.35% when compared with that of the control subjects (p value < 0.0005). The mean Tidal volume of showed statistically significant increase of 20.21 % when compared with the mean Tidal Volume of the non pregnant subjects (p value < 0.0005). The mean residual Volume (RV) showed a statistically significant decrease of 16.27% when compared

with that of the control non pregnant women ($p < 0.0001$). A non significant increase of 5. 35 % in the mean Minute Volume (MV) is noticed in the II trimester pregnant subjects as compared with the mean Minute Volume (MV) of the control non pregnant subjects ($p = 0.0001$). The mean Vital Capacity (VC) of the subjects in the II trimester pregnancy showed a non significant increase of 3.50% when compared with the mean Vital Capacity (VC) of the control subjects (p value = 0.0145).

Table No. 4- Comparison of Mean value's of different lung function parameters between control and III trimester pregnant women

	Control Mean±Sd	Third Trimester Mean±Sd	P-Value
ERV in litres	0.8620 ± 0.008660	0.7858 ± 0.004661	< 0.0005
TV in Litres	0.4232 ± 0.003450	0.5267 ± 0.01372	< 0.0005
VC L/min	4.011 ± 0.02022	4.207 ± 0.03687	< 0.0005
RV in Litres	2.120 ± 0.009420	1.8468 ± 0.007921	< 0.0005
MV Litres/min	7.224 ± 0.03842	7.824 ± 0.04522	< 0.0005

The mean Expiratory Reserve Volume (ERV) in the III trimester subjects has shown a statistically significant decrease of 9.87 % as compared to the control subjects (p value < 0.0005). The mean Tidal volume of showed statistically significant increase of 30.51% when compared with the non pregnant subjects(p value < 0.0005).

The mean Residual Volume (RV) showed a statistically significant decrease of 23.375 % when compared with control non pregnant subjects ($p < 0.0005$). An non significant increase of 9.64 % in the mean Minute Volume (MV) is noticed in the III trimester pregnant subjects as compared with the of the control nonpregnant subjects ($p = 0.0005$). Vital Capacity (VC) showed a non significant increase of 8.60% when compared with the mean of the control subjects (p value= 0.0005).

Table No. 5 - Mean Value's of ERV, TV,VC, RV & MV in different trimester's of pregnancy

	Control Mean±Sd	Ist Trimester Mean±Sd	Second Trimester Mean±Sd	Third Trimester Mean±Sd
ERV in litres	0.8620 ± 0.008660	0.8336 ± 0.003964	0.7062 ± 0.004381	0.7858 ± 0.004661
TV in Litres	0.4232 ± 0.003450	0.4546 ± 0.003535	0.4885 ± 0.004890	0.5267 ± 0.01372
VC L/min	4.011 ± 0.02022	4.116 ± 0.03434	4.122 ± 0.03923	4.207 ± 0.03687
RV in Litres	2.120 ± 0.009420	1.9624 ± 0.01882	1.9495 ± 0.008944	1.8468 ± 0.007921
MV Litres/min	7.224 ± 0.03842	7.345 ± 0.05149	7.558 ± 0.08005	7.824 ± 0.04522

Expiratory Reserve Volume (ERV) in the pregnant subjects (as compared with the controls) as the pregnancy advances reaching its maximum decrease by the end of III trimester. Mean Tidal Volume progressively increased as pregnancy

advances reaching its maximum value at term which is statistically significant. Gradual decrease in the mean residual Volume (RV) in the pregnant subjects from the I to the III trimesters which is statistically significant. Thus there is a gradual increase in the mean Minute Volume (MV) of the pregnant subjects as they proceed to term when compared with the controls. The mean Vital Capacity (VC) of the subjects in the I trimester pregnancy showed a non significant increase of 3.48 % when compared with the mean Vital Capacity (VC) of the control. The same parameter relating to the subjects in the II and III trimester pregnancy showed a statistically significant increase of 3.50 % and 8.60% respectively as compared with the mean Vital Capacity (VC) of the control subjects.

Discussion

The physiological changes induced by pregnancy have been summarized by Nelson Piercyde [10]. Vital Capacity may be increased by about 100 to 200ml ; Inspiratory Capacity increases by about 300ml by late pregnancy; Expiratory Reserve Volume decreases from a total of 1300ml to 100ml ; Residual Volume decreases from a total of 1500ml to 1200ml ;Functional Residual Capacity (FRC), the sum of Expiratory Reserve Volume (ERV) and Residual Volume (RV), is reduced by about 500ml; Total Volume increases considerably from about 500-700ml ; Minute Ventilation increases by 40%., from7.5 L/min to a total of 10.5L/minute; this is primarily due to increase in Tidal Volume (TV) because the respiratory rate remains unchanged. These changes are induced to help the increased supply of oxygen as basal oxygen consumption increase incrementally by20-40 ml/minute every month in the second half of pregnancy. As a result, arterial PO2falls very slightly, PCO2 averages 28 mm Hg, plasma pH is slightly alkaline at 7.45 and bicarbonate decreases to about 20 meq/L.

Our observation that there is an increase in Tidal Volume and a decrease in Expiratory Reserve Volume (ERV) is in agreement with the results of shailja et al[11]. An increase in tidal volume and minute ventilation which occurs in pregnancy was observed in many studies[12]

Some studies showed significant rise in Forced Vital Capacity (FVC) while other studies showed decrease in FVC[13,14,15].

Pradhan et al[16] studied All the pulmonary function parameters were increased except PEFR in group II as compared to group I but this was not statistically significant. The PEFR was increased in group II as compared to group I and this was statistically significant. Conclusion: The PEFR was increased significantly in 36 weeks pregnancies, and should be interpreted carefully in pregnant women.

Neeraj et al[17] study was conducted on 100 pregnant women in third trimester of uncomplicated pregnancy (Test group) and 100 age-matched non-pregnant women (Control group) in the age group of 25 to 35 years. Pulmonary function test parameters FVC, FEV1, PEFR and FEF25-75% recorded using Medspiror. All parameters except FEV1/ FVC ratio were found to decline in the Test group as compared to the Control group. This study validates the physiological changes in pulmonary function brought by pregnancy and highlights the need to compile expected and accepted alterations in predicted values of PFT in comparison with the non gravid states for safer outcome of the pregnancy.

A decrease in FVC, FEV1 & PEFR in pregnancy was observed by Neeraj Candy S et al [18] and our study do not correlate with this study. A non significant increase in FEV1 and significant increase in VC was observed in our study. Decline in PEFR during the third trimester of pregnancy was observed by HemantDeshpande et al [19] correlates with our study.

Chinko et al[20] found that Peak expiratory flow rate was found to be significantly lower among the pregnant females compared to the control PEFR was also significantly decreased with increased gestational age ($p<0.05$), similar study was also done by rasheed et al[21]

Thus our study validates the physiological changes, adaptations and decline in pulmonary function in pregnancy especially in the last trimester. The effect of the enlarged uterus displacing the diaphragm upwards is evident in the significantly reduced forced vital capacity among the pregnant subjects compared to the controls. The mechanical factors are not the only causative factors. Other factors such as hormonal influences also play a role, in altering and compromising the pulmonary flow parameters like FEV1, PEFR and FEF(25-75%.). We found that the FEV1 / FVC ratio shows a definite increase due to less decrease in FEV1

as compared to FVC. our study correlates with harirah et al[22]

TILWANI et al[23] found that There is statistically significant relationship between air pollution and poor lung function. Decline in the lung parameters FVC, FEV1, FEV1/FVC, FEF25-75% and PEFR are observed in the population residing in these areas than the less exposed population.

Jadhav et al [24]found that FVC, FEV 1% FEV3, PEFR and MVV ,The readings were compared of first and second trimester, second and third trimester and first and second trimester. Following observations were noted. PEFR was found to be significantly decreased in first trimester while other readings were not significantly decreased in first trimester as compared to second and third trimester. All the parameters also compared with control group. It showed that there was decline in all the values compared to control values, which was highly significant. Similar study was done by Santha kumari et al [25].

The present study highlights observation that the respiratory parameters are significantly compromised due to gravid state in the last trimester of pregnancy in Indian subjects. We feel, to establish norms on predicted and desired PFT values in various phases of pregnancy, extensive studies on larger population need to be done and the correction factors be introduced while evaluating PFT readings in such patients. In the absence of these norms of normal deviation from non gravid states, the computerized values obtained through routine spirometry may give inaccurate information of the respiratory status of the patient to the clinicians, obstetricians and anesthetists managing complications in the last trimester of pregnancy.

Conclusion

Comparative study of pulmonary function tests on different trimesters of pregnancy showed that respiratory parameters like PEFR significantly compromised due to mechanical pressure of gravid uterus, diaphragm restricting the movement of lungs especially in third trimester of pregnancy. There was decrease in respiratory parameters from first to third trimesters of pregnancy due to poor nutrition because all the subjects coming from middle class and poor socio-economic status. Poor nutrition may cause decrease in functions of respiratory muscles. To establish the cause of decrease in respiratory parameters, further studies are to be undertaken by hormonal assay in different trimesters to know effect of increase of hormones on respiratory parameters.

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