LONGITUDINAL VENTILATORY FUNCTION (STATIC AND DYNAMIC) STUDIES DURING DIFFERENT TRIMESTERS IN PREGNANT WOMEN

by

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Introduction

During the course of pregnancy foetus gradually grows and, therefore, pregnancy should bring about changes in all the systems of the mother to accommodate the needs of the developing foetus. It can be said that pregnancy manifests as one of the most remarkable states of physiological adaptations. Cardiovascular, haematological, hormonal, metabolic and excretory changes during pregnancy have been studied in detail. However, changes in pulmonary function have been sparingly reported with conflicting results. While some investigators have reported that pregnancy has little effect on overall respiratory function, others have stated that such factors as gradual abdominal distension, enlarged breasts, and inherent circulatory changes affect the respiratory physiology in the pregnant women. There have been only a few reports of serial pulmonory function studies in normal pregnant women. In the present work longitudinal studies of ventilatory function in 25 normal women during each of the three trimesters of pregnancy have been made.

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Material and Methods

Young healthy pregnant women during their first trimester were selected from ante-natal clinics of Sultania Zanana Hospital, Bhopal. Respiratory, cardiovascular or renal disorders were ruled out by thorough history taking and after a careful clinical examination. Haemoglobin content of all the women studied was more than 70%. Subjects were first studied during 1½-2½ months of pregnancy. Observations were made at about 3 months intervals after the first visit.

A total of 63 pregnant women were studied during first trimester, of which 25 were followed up upto the third trimester. The remaining subjects were dropped from analysis on account of abortion, miscarriage, premature delivery, toxaemia of pregnancy or because they did not turn up. The age varied from 18-25 years and the height ranged from 141-160 cm.

Static ventilatory function tests such as Tidal Volume (V_T), Inspiratory Reserve—Volume (IRV), Inspiratory Capacity (IV), Expiratory Reserve Volume (ERV) and

Vital Capacity (VC) and dynamic ventilatory function tests such as Respiratory Minute Volume (RMV), Forced Expired Vital Capacity (FEVC), Forced Expiratory Volume—First second (FEV_1) FEV_1 percentage ($FEV_1\%$), Maximum Mid Expiratory Flow Rate (MMEFR) and Maximum Voluntary Ventilation (MVV) and also the Respiratory rate (RR) were determined by using Toshniwal Expirograph. The speed of the Kymograph was fixed at 60 mm/minute throughout the recordings except for forced expiratory expirogram when the speed used was 1200 mm/min.

All observations were made in sitting posture. Each test was explained and demonstrated to every subject to achieve maximum co-operation. All gas volume were corrected to BTPS. Weights were recorded at every visit (trimesterwise) and surface area (SA) was calculated by reference to the nomogram of Boothby and Sandiford (based on Dubois formula).

Significance of changes occurring in static and dynamic lung volume was tested statistically by paired 't' test.

Results

Results of static and dynamic lung volume measurements have been shown in Table-I. Mean difference and significance of changes between second and first trimester, third and first trimester, and also between third and second trimester have been summarized in Table-II.

Pregnancy was associated with a progressive increase in mean V_T which in 3rd trimestetr was 0.14L(35%) higher than the mean value in 1st trimester. Mean IRV in 3rd trimester was 0.187L (19%) higher than that of 1st trimester. However, there was a decrease in ERV which was 0.309L (36%) lower in 3rd trimester as compared to the mean value in 1st trimester. These changes were statistically significant. Vital capacity tended to increase, in 3rd trimester the mean value was 0.116L (5%) higher than that of the 1st trimester, which was not statistically significant.

RMV showed a steady increase throughout pregnancy. During 3rd trimester the mean RMV was 3.128 L/min (37%) higher as compared to the mean value in

TABLE I

Static and dynamic lung volume values during the three trimesters of pregnancy in 25 Normal Pregnant Women

Measurement	1st Trimester mean ± S.D.	2nd Trimester mean ± S.D.	3rd Tlimester mean ± S.D.
SA (Sq. m.)	1.308 ± 0.101	1.357 ± 0.099	1.397 ± 0.091
V_T (L)	0.403 ± 0.095	0.476 ± 0.140	0.543 ± 0.162
IRV (L)	0.975 ± 0.282	1.095 ± 0.410	1.162 ± 0.324
IC (L)	1.379 ± 0.284	1.689 ± 0.484	1.700 ± 0.323
ERV (L)	0.848 ± 0.218	0.629 ± 0.143	0.539 ± 0.153
VC (L)	2.088 ± 0.561	2.206 ± 0.431	2.204 ± 0.397
RMV (L/min)	8.362 ± 1.587	9.877 ± 2.119	11.490 ± 2.932
FEVC (L)	2.290 ± 0.447	2.289 ± 0.432	2 349 ± 0.388
$FEV_1\%$	84.504 ± 6.137	85.044 ± 5.442	85.162 ± 5.601
MMEFR (L/sec)	2.371 ± 0.745	2.551 ± 0 732	2.584 ± 0.645
MVV (L/min)	70.859 ± 16.638	65.307 ± 14.897	62.474 ± 12.240
RR/min	21 280 ± 2.227	21.120 ± 2.242	21.520 ± 1.939

TABLE II

Statistical Anaylsis of Changes in the Static and Dynamic Lung Volume Values During the Course of Pregnancy in 25 Normal Pregnant Women

Measulement	2nd-1st trimester mean ± S.D.	3rd-1st trimester mean ± S.D.	3rd-2nd trimester mean ± S.D.
V_T (L)	0.073 ± 0.115 (t = 3.174)**	0.140 ± 0.127 (t = 5.512)**	0.067 ± 0.101 (t = 3.317)**
IRV (L)	0.121 ± 0.269 (t = 2.249)*	0.187 ± 0.251 (t = 3.725)**	0.066 ± 0.215 (t = 1.535)
IC (L)	0.310 ± 0.321 (t = 4.829)**	0.321 ± 0.233 (t = 6.888)**	0.011 ± 0.296 (t = 0.186)
IV (L)	—0.216 ± 0.217 (t = 4.977)**	—0.306 ± 0.208 (t = 7.356)**	—0.090 ± 0.173 (t = 2.601)*
VC (L)	0.118 ± 0.322 (t = 1.832)	0.115 ± 0.365 (t = 1.575)	—0.003 ± 0.212 (t = 0.071)
RMV (L/min)	1.514 ± 1.817 (t = 4.166)**	3.128 ± 2.579 (t = 6.064)**	1.613 ± 2.054 (t = 3.926)**
FEVC (L)	0 ± 0.239 (t = 0)	0.059 ± 0.244 (t = 1.209)	0.059 ± 0.195 (t = 1.513)
FEV_1%	0.522 ± 4.384 (t = 0.595)	0.641 ± 5.680 (t = 0.564)	0.118 ± 3.647 (t = 0.162)
MMEFR (L/sec)	0.180 ± 0.577 (t = 1.560)	0.213 ± 0.671 (t = 1.587)	0.033 ± 0.632 (t = 0.261)
MVV (L/min)	—5.548 ± 13.638 (t = 2.034)	—8.381 ± 11.776 (t = 3.558)**	—2.833 ± 13.779 (t = 1.028)
RR/min	—0.160 ± 2.304 (t = 0.347)	0.240 ± 2.471 (t = 0.486)	0.400 ± 1.732 (t = 1.155)

*Significant (since calculated $t > t_{0.05,24}$)
**Highly significant (since calculated $t > t_{0.01,24}$)

the 1st trimester. However, a declining trend was noted in respect of MVV which in 3rd trimester was 8.385 L/min (12%) lower than the mean value in 1st trimester. These changes were found to be statistically significant.

A statistically insignificant increase in FEVC, FEV_1%, MMEFR and RR was observed. FEV_1% was found to be within the normal limit and no subject had less than 70% FEV_1.

Discussion

The aim of this study was to find out the changes, if any, in static and dynamic ventilatory function during the course of pregnancy, since such longitudinal studies have been scant. Most of the earlier workers studied ventilatory function in late pregnancy and compared them with those of postpartum period in the same subject or between late pregnancy in one group of subjects and non-pregnant state in other groups (Alward, 1930; Rubin *et al* 1956; Gee *et al* 1967; Pandya *et al* 1972; Dasgupta, 1973; Pande *et al* 1973; Baldwin *et al* 1977; Holdcroft *et al* 1977; Skandhan *et al* 1977 and Pandya *et al* 1980).

V_T AND IRV progressively increased during the course of pregnancy and the results were in consonance with those of other workers (Cugell *et al* 1953; Gazioglu *et al* 1970 and Alaily and Carrol 1978). The progressive decrease in ERV was also in agreement with most of the other reports (Cugell *et al* 1953 and Alaily and Carrol, 1978). However, Gazioglu *et al* (1970) reported no change in ERV. In the present study, VC did not show any significant change. Similar observation had been made earlier (Thomson and Cohen, 1938; Cugell *et al* 1953; Gazioglu *et al* 1970 and Alaily and Carrol, 1978). Increase in V_T was considered to be due to an increased level of progesterone, corticosteroids and relaxin which have a relaxing effect on smooth muscles. The decreased ERV was due to decreased negativity of intrapleural pressure brought about by upward displacement of diaphragm by enlarged uterus. The decrease in ERV was compensated by a concomitant increase in inspiratory capacity so that the sum of the two (i.e. vital capacity) remained unaltered.

Progressive increase in RMV as observed in the present study was also reported by Cugell and his associates (1953). The respiration rate in the present study did not show any significant change and therefore, the increase in RBV was due to an increase in V_T while respiratory frequency remained unchanged. It is now generally agreed that the hyperventilation in pregnancy is produced by the increased circulating level of progesterone which has a stimulating effect on the respiratory centre (Prowse and Gaensler, 1965 and Lambertsen, 1966).

Though there was a tendency for FEVC, $FEV_1\%$ and MMEFR to be increased during the course of pregnancy, but the increase was not statistically significant. Similar observations had been made by Cameron *et al* (1970). The maintained FEVC, $FEV_1\%$ and MMEFR inspite of increasing uterine size and increasing blood volume could be due to a state of relative bronchodilatation which might be brought about by the smooth muscle relaxing action of certain hormones such as progesterone, relaxin and corticosteroids. Gee *et al* (1967) also reported a decrease airway resistence in pregnant women. It has also been reported that pregnant women tolerate various bronchospastic disorders, such as bronchial asthma, remarkably well (Schaeffer and Silverman, 1961). Moreover, in the pregnant women at full term, respiratory distress is rarely sufficient to interfere with ordinary prysical activity, although they have such seeming handicaps to breathing as an elevated diaphragm with restricted excursion, a greatly enlarged abdomen and heavy breasts. On the other hand, the patient whose abdomen is distended from other causes often suffers much respiratory difficulty (Rubin *et al*, 1956).

MVV declined progressively during the course of pregnancy, however, Cugell *et al* (1953) did not find any significant change. Apart from the caliber of the airways, the MVV was also influenced by the efficiency of the respiratory apparatus as a pump. Since this pump was at a certain mechanical disadvantage during pregnancy, the MVV might be reduced without any obstruction to the air flow.

Summary

Serial ventilatory function studies were undertaken in 25 normal pregnant women to quantitate the changes occurring in the static and dynamic ventilatory functions. Pregnancy was associated with progressive increase in V_T and IRV, decrease in ERV with no significant change in VC. RMV and MVV were increased and decreased respectively during the course of pregnancy, whereas FEVC, $FEV_1\%$, MMEFR and respiratory rate did not

show significant alterations. Increase in RMV was due to increase in V_T with unaltered respiratory rate. MVV was reduced because the respiratory pump was at a certain mechanical disadvantage during pregnancy. Inspite of decreased MVV flow rates remained unaltered probably because of the increased level of smooth muscle relaxing hormones during the course of pregnancy.

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