TOTAL RESPIRATORY COMPLIANCE DURING HUMAN PREGNANCY

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SUMMARY

The weekly determination of total respiratory compliance was undertaken in relation to gestational age in 271 pregnant (8-36 weeks) and 37 non pregnant (once only) women of 18-35 years of age. The method of Cherniack and Brown was followed by using closed circuit Collins Respirometer. The mean value (± standard deviation) of total respiratory compliance during first, second and third trimester of pregnancy was 109.45 (± 29.47), 87.00 (± 25.85) and 69.30 (± 19.78) ml/cm H_2O respectively. The mean value of this parameter in nonpregnant women, 108.24 (± 35.01) ml/cm H_2O did not differ from that of the first trimester observation. But this parameter decreased significantly ($p<0.001$) during second (19.59%) and third trimester (35.97%) compared to non pregnant control group. In addition the difference between the second and the third trimester was significant ($p<0.001$). This reduced compliance may be responsible for the increasing dyspnea during the course of pregnancy alongwith other causes, as chest wall or lung stretch receptors recognize the increased tension required for ventilation.

Introduction

Alterations in normal respiratory functions are brought about by both anatomical as well as hormonal changes during the course of pregnancy. The reduction in resting lung volume like functional residual capacity (FRC) and expiratory reserve volume (ERV) during pregnancy might be associated with an altered pulmonary mechanics. The mechanics of respiration, particularly compliance, depend largely on elastic forces in lung as well as chestwall tissue structures and studies on them during pregnancy are very few (Gee et al, 1967; Farmen and Thorpe, 1969; Marx et al, 1970; Shearman, 1972). Most of them are reported only during the term and just after delivery. There are no reports of total respiratory compliance in spontaneously breathing conscious pregnant women during their different gestational ages. We undertook static total respiratory compliance studies throughout the pregnancy.

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Subjects and Methods

The experiment was carried out in antenatal clinic of V.S. General Hospital and Smt. N.H.L. Municipal Medical College, Ahmedabad, on 271 healthy pregnant women of 18-35 years of age, during their different gestational periods. They were all from similar height (mean, 152 cm) and age (mean, 24 years) group. They had no organic cardio-pulmonary disease and anemia. None had complained of more than the usual degree of dyspnea as pregnancy advanced. Matching with height and age and socioeconomic status, a control study on 37 nonpregnant healthy women was undertaken.

The total respiratory compliance was determined by positive pressure breathing technique (Cherniack and Brown, 1965) using closed circuit Collins Respirometer (Warren E.Collins, Boston, MA, USA). Before the actual test, the subjects were trained in mouth breathing, with nose clipped, through the apparatus and directed to breath normally and to be relaxed as far as possible. After the satisfactory training, they were asked to come in the laboratory in the morning for the actual test. After 30 minutes bed rest in the laboratory, the experiment was started on them in supine position. The volume changes were recorded by applying different pressures ranging 2-10 cm H_2O through the weighted bell at least for four times and a mean was calculated and was corrected at body temperature and pressure, saturated (BTPS). Volume was expressed as ml/cm H_2O.

Most of the physiological parameters during early pregnancy, particularly in first and second month, remain unchanged (Cugell et al, 1953). In our present study, the total respiratory compliance in nonpregnant women was measured once only. Hence to interpret the weekly variations statistically, the 8th week data served as normal and compared with those of later weeks of pregnancy. Whereas data of nonpregnant women served as control compare to first, second and third trimester of pregnancy. The presentation of results has centered on changes which were expressed as arithmetical means (± standard deviation) for the group. The percentage changes were also calculated to relate the difference to the initial values.

TABLE - I
TOTAL RESPIRATORY COMPLIANCE (ML/CM H_2O) DURING DIFFERENT WEEKS IN PREGNANCY

Duration of pregnancy (Week)	No. of subjects	Mean	SD ±	Percent changes over compliance	Significance 't'	Significance p
8	32	109.20	28.359	—	—	—
12	36	109.66	30.830	+ 0.42	0.0637	NS
16	20	105.78	28.859	- 3.13	0.4209	NS
20	20	92.18	23.431	- 15.58	2.4520	< 0.020
24	36	75.10	19.224	- 31.24	5.9150	< 0.001
28	49	72.10	20.422	- 33.97	6.8882	< 0.001
32	47	67.44	19.907	- 38.24	7.7361	< 0.001
36	31	67.70	18.672	- 38.00	6.8668	< 0.001

The statistical significance was determined by using unpaired 't' test.

Results

From Table I, it is evident that the total respiratory compliance during 8th, 12th and 16th week of pregnancy was almost similar and found to be 109.20, 109.66 and 105.78 ml/cm H_2O respectively. But from 20th week onward a signficant fall (92.18 ml/cm H_2O, $p<0.02$) was noted in comparison with 8th week's observation. Maximum reduction in compliance, 67.44 ml/cm H_2O or 38.24 percent, was evident in 32 week of gestation.

Again after analysis of this parameter according to trimester, the mean values were found to be 109.45, 87.00 and 69.30 ml/cm H_2O during first, second and third trimester respectively. The same in 37 nonpregnant women, 108.24 ml/cm H_2O, did not differ from that of first trimester observation. But the compliance decreased significantly ($p<0.001$) during second (19.59 percent) and third trimester (35.97 percent) compared to nonpregnant group. Again the difference between second and third trimester was significant ($p<0.001$).

Discussion

During this study, we could not measure the thoracic gas volume in our subjects. It was a total volume change at FRC level after positive pressure breathing in response to change in alveolar pressure induced by the weighted bell which in effect was taken as a measure of total respiratory compliance. The present data do not represent absolute compliance values because they were obtained in supine position rather than standing position (Ferris et al, 1959). However, they are reliable for comparison since a steady state was maintained throughout this study.

The present observation established that the total respiratory compliance was gradually and significantly decreased from 20th week of gestation and a maximum reduction of 38.24 percent was observed during 32nd week. Earlier Marx et al, (1970) reported 36 percent reduction of total respiratory compliance in lithotomy position in 5 term pregnant women under anaesthesia. Whereas Farman and Thorpe (1969) observed only 20 percent reduction in total respiratory compliance under anaesthesia. It is of interest, but difficult at present to speculate about the mechanism of decrease in total respiratory compliance as the pregnancy advanced; until recently a good number of direct measurements of lung compliance in pregnancy were not available. It was thought that the reduction in lung volume due to the diaphragmatic elevation and the possibility of a slight increase in pulmonary blood volume in pregnancy would make the lung less distensible (Burwell, 1938; Novy and Miles, 1967). It is important to remember that pulmonary compliance is related to lung volume (Marshall, 1957; Caro et al, 1960), more specifically related to functional residual capacity (Nunn, 1978). The reduction in functional residual capacity during pregnancy, which is fairly uniformly agreed upon (Bonica, 1967), would undoubtedly be associated with the change in compliance. Again this reduction in functional residual capacity is in contrast with the preservation of vital capacity (Das, 1985) suggesting that lung compliance is not greatly changed. By means of oesophageal ballon technique, Gee et al, (1967) found that the lung compliance is not altered statistically during pregnancy and this was confirmed by Shearman (1972). Again, the report of only chest wall elasticity in two pregnant women, by lat-

ter author, suggested that the outward recoil of the chest wall was reduced and the end expiratory pressure in lungs had become more positive as pregnancy advanced. Therefore, the present observation of reduced chest lung compliance may reasonably be ascribed due to changes in the elastance mainly of chest wall which increase gradually during the course of pregnancy. It will not be wrong, if one assumes that the dyspnea in pregnancy which is associated with disproportional increase of pulmonary ventilation and oxygen consumption than that of vital capacity (Thomsom and Cohen, 1938; Cugell et al, 1953; Das, 1985), may be a concomitant of decreased compliance, as chest wall stretch receptors recognize the increased tension required for ventilation (Welch, 1977).

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