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Study of Minute Ventilation, Maximum Voluntary Ventilation and Dyspneic Index During Pregnancy: An Observational, Prospective and Comparative Study

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Abstract

Introduction: This study was designed to evaluate the Minute ventilation (MV). Maximum Voluntary Ventilation (MVV) & Dyspneic Index (DI) in different trimesters of pregnancy and compare the results with non pregnant control group.

Materials and Method: This study was carried out in 80 healthy women in the age range of 20-40 years with 20 subjects each in 1st, 2nd, 3rd trimesters of pregnancy and non-pregnant control group. The respiratory parameters were recorded in study and control groups. Statistical analysis was done by SPSS Software Package.

Results: It was observed that there was a significant decrease in MVV and dyspneic index (DI) in all trimesters of pregnancy and an insignificant variation in MV when compared to the control group. These changes are due to pressure of enlarging gravid uterus, elevating the diaphragm and restricting the movements of lungs thus hampering forceful expiration. The decrease seen in MVV in 1st trimester might be due to the effect of bronchoconstriction due to decreased alveolar Pco2.

Conclusions: Decrease in respiratory parameters was seen particularly in first trimester of pregnancy compared to 2nd & 3rd. The normal Minute Ventilation tries to maintain the respiratory need of pregnancy at rest. At increased physiological needs of respiration or during exercise the decreased Maximum Voluntary Ventilation makes pregnant female dyspneic.

Keywords: *Pregnancy, Minute Ventilation, Maximum Voluntary Ventilation and Dyspneic Index.*

Introduction

The changes that occur in thoracic cage are rise in the diaphragm by four centimetres, widening of sub-costal angle increasing the transverse diameter by two centimetres & thoracic circumferences by six centimetres. These changes begin before the size of uterus can have an effect. [1] In Pregnant women there is increases in minute ventilation (VE), tidal volume, alveolar ventilation and a reduction in arterial PCO2. [2, 3] There is renal excretion of bicarbonate, resulting in a state of partly compensated respiratory alkalosis (arterial pH 7.43-7.47). [4] These effects appear in the first trimester and may promote placental gas exchange before development of an effective fetal circulatory system. [4]

The aim of the study was to evaluate the effect of pregnancy on Static & dynamic lung volumes and capacities in the subjects of Indian pregnant women in the age range of 20-40 years in different trimesters of pregnancy and compare them with healthy age matched non-pregnant control group.

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Material and Method: This observational, prospective and comparative study was conducted in the Department of Physiology and Obstetrics & Gynaecology of Katihar Medical College, Katihar to determine the pulmonary function changes in 1st, 2nd & 3rd trimesters of pregnancy and results were compared with age matched healthy non pregnant women. This study was conducted for 6 months from October 2017 to April 2018.

The study group comprised of 80 pregnant women in the age group of 20-40 years. This study group was further subdivided into 3 subgroups. Each sub group comprised of 20 women in 1st, 2nd and 3rd trimesters of pregnancy. The Control Group comprised of 20 healthy age matched (20-40 years) non pregnant women. The study was explained to the subjects. An informed written consent was obtained. A thorough physical & systemic examination (cardiovascular and respiratory system) of each subject was done. Recordings were taken between 8 am to 11 am.

Inclusion criteria:

1. All apparently healthy female subjects (80 pregnant and 20 non pregnant) between 20-40 years of age group were included in this study.
2. The health status of the subject was determined by history taking and thorough clinical examination.

Exclusion criteria:

1. Asthma,
2. Acute respiratory infection in the previous three months,
3. History or clinical signs of cardiovascular diseases, diabetes mellitus, hypertension, tobacco consumption, alcohol intake,
4. Endocrine disorders,
5. Obesity,
6. Moderate to severe anaemia.

The following parameters were recorded in each subject:

A. **Anthropometric parameters** like Height (in centimetres), Weight (in kilograms). Body Mass Index

B. **Respiratory parameters**: The subjects were informed about the procedure. For each test, three readings were taken. The highest of the three was considered for calculation. All tests were recorded in a sitting posture at room temperature, in morning hours.

I. Respiratory Rate (RR) (cycles/minute) was recorded.

II. The following pulmonary parameters were recorded by Computerized Spirometer

1. MV (Minute Ventilation =TV x RR in L/min). Minute Ventilation (MV) or Pulmonary Ventilation (PV) is the volume of air expired or inspired by the lungs in one minute. Normal value: 6 L/minute. [7]
2. MVV (Maximum Voluntary ventilation in L/min). It is the largest volume of air that can be moved in and out of the lungs in one minute by maximum voluntary efforts. Normal: 120-170 litres/minute. [8]
3. DI (Dyspneic index = MVV-MV)/MVV) x 100. Refers to breathing reserve percentage of MVV. Breathing reserve is the difference between MVV & MV. Normal value-70-95% and DI <60% is dyspnea. [9]

BMI: Body mass index, RR: Respiratory rate, MVV: Maximum voluntary ventilation, MV: Minute ventilation, DI: Dyspneic index of pregnancy.

Statistical analysis: The results were expressed as Mean±SD. Comparison done between the study (1st, 2nd and 3rd trimesters of pregnancy) and control groups and data were statistically analysed using SPSS software. p value ≤0.05 was considered statistically significant.

Results

Table 1: Age, anthropometric and respiratory parameters of different study group subjects

Parameters	Group 1	Group 2	Group 3	Group 4	P Values
Age (yrs)	26.08±5.76	27.02±4.41	26.76±3.57	27.84±3.39	0.200
weight (kG)	56.68±8.61	50.24±6.09	52.48±6.08	57.46±8.23	0.000
bmi (kg/m^2)	22.17±3.4	20.91±3.76	21.37±3.69	23.71±2.98	0.001
rr (PM)	16.72±3.00	23.26±3.00	24.38±4.00	27.26±3.00	0.000
mvv (l/min)	70.28±18.63	39.82±11.78	40.61±14.16	40.35±13.72	0.000
mv (l//min)	14.34±7.54	14.68±8.09	14.28±7.22	15.42±5.84	0.752
DI (%)	78.35±11.80	60.84±25.87	48.98±53.01	55.66±29.55	0.000

Anthropometric parameters: The Mean±SD of age, weight, BMI have been shown in Table 1. All groups are similar by age. There was a decrease in weight in 1st & increase in 3rd trimester compared to control. BMI increased significantly in 3rd trimester compared to control

Respiratory parameters: The Mean±SD of RR. MVV, MV and DI have been presented in Table I. There was a gradual increase in RR from 1st to 3rd trimesters compared to control. There was no significant difference in the minute ventilation between the study and control groups. A highly significant decrease in MVV was observed in all trimesters with a maximum decrease in 1st trimester. DI was significantly reduced in all trimesters compared to control group with maximum decrease in 2nd trimester.

Discussion

The present study showed a significant increase in weight & BMI in 3rd trimester. [10] A significant increase in RR from 1st to 3rd trimester of pregnancy as compared to control group which is in agreement with Bernhard Heidemann, who stated that PaCO2 falls and then levels off at 4.1kPa (31 mmHg) by the end of the first trimester. This is caused by a 10% increase in the respiratory rate, secondary to progesterone mediated hypersensitivity to CO2, and an increase in alveolar and minute ventilation, secondary to increased respiratory rate and tidal volume.[11]

Present study showed insignificant increase in MV in all trimesters as compared to control group. A study by Emilia Kolarzyk showed increase in MV during pregnancy. The increase in MV was caused by a significant increase in tidal volume. [12] The study by Aaron P also showed increase in MV which is due to changes in osmolality, (SID) strong ion differences & angiotensin II levels, which have been implicated in the control of ventilation.[13]

There was a significant decrease in MVV in all trimesters compared to control group with maximum decrease in 1st trimester. The decline in the MVV in first trimester is due to morning sickness (lack of nutrition) and also due to lodging of trophoblast cell in the alveoli from the maternal uterine sinuses. In the 2nd and 3rd trimester, it may be due to mechanical pressure of enlarging gravid uterus, elevating the diaphragm and restricting the movements of lungs and thus hampering the forceful expiration and may also be due to bronchoconstriction effect of decreased alveolar Pco2. [14] Present study also demonstrates a significant decrease in DI in all trimesters as compared to control group with maximum decrease in 2nd trimester. The decrease in the DI shows that pregnant women in all trimesters are dyspneic on exertion, [5] but some individuals showed negative DI indicating dyspnea at rest in all trimesters.

Conclusion

The normal Minute Ventilation tries to maintain the respiratory need of pregnancy at rest. At increased physiological needs of respiration or during exercise the decreased Maximum Voluntary Ventilation makes her dyspneic. Further studies are needed to establish the cause for decrease in respiratory parameters particularly in first trimester of pregnancy compared to 2nd & 3rd.

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