INTRODUCTION

INTRODUCTION

Human body comprises of different elements, salts, tissues, organs, systems and pranas. All these structures carry out their special functions (cooperating and helping each other) in a harmony. Each structure has its own significance and importance. Starling once said, " The physiology of today is medicine of tomorrow." For performing normal specific and general physiological functions smoothly, all body structures require oxygen - the basic and prime necessity. Consequently, human beings remain healthy for many years during their life span. It is a well-known fact that one can't survive without oxygen. All the living cells form carbon dioxide, a gaseous metabolite as a result of oxygen utilization. Therefore, continuous adequate supply of oxygen and removal of formed carbon dioxide has to be maintained. The sensitivity and endurance of cells of different tissues, organs and systems to oxygen and carbon dioxide may vary and this becomes a deciding factor for performance of respiratory system and consequently its efficiency. Human beings have been gifted by an efficient respiratory system that along with its associative structures is efficient to fulfill body needs of oxygen in altered situation as well.

Anatomy and Physiology of Respiratory System

Respiratory system comprises mainly of nostrils, nasopharynx, pharynx, trachea, bronchi, bronchioles, alveolar ducts, alveolar air sacs and pulmonary alveoli. The trachea divides into right and left bronchi, which enter the respective lungs through the hylum; the rest of the structures enumerated above are present in each lung to take part in mechanism of respiration Pleura form the outer covering of the lungs and consist of visceral and parietal layer separated from each other by a thin layer of pleural fluid. Thoracic cavity is completely closed structure with only larynx as an opening, which through bronchi communicates with the lungs. The lungs are elastic in nature that can expand and recoil during inspiration and expiration respectively. Position of thoracic cavity at end of quiet expiration is taken as normal. Any increase in thoracic cavity constitutes inspiration while its return to normal is expiration.

Physiologically, a steady state is a balanced condition of responsive adjustment to any particular environmental condition or stress. The function of respiration, circulation, electrolyte and water balance, metabolism and body temperature are so interlocked that alteration of one evokes responsive adjustment in other to establish a new dynamic steady state. When any such changes occur, respiration

adjusts rapidly to metabolic demand, assuring the tissues an adequate supply of oxygen and removing excess carbon dioxide (85).

Mechanism of Respiration

Respiratory system is concerned with process of respiration, in order to supply adequate oxygen to blood and tissues and to remove carbon dioxide from the body. Thus it is a process of gaseous exchange between the tissues and its environment (internal) which is known as internal or tissue respiration. Exchange of gases between the body and external environment taking place in the lungs is known as external respiration i.e. breathing in and out respectively. Inspiration is an active and dominant act brought about by active muscular contractions while expiration is merely a passive act that follows the relaxation of respiratory muscles. The muscular activity during inspiration brings about enlargement of thoracic cavity in all dimensions i.e. vertical, transverse and anteroposterior diameters. Reverse changes occur during expiration.

Process of respiration occurs mainly through muscular mechanism and nervous mechanism that is meant for regulation and coordination. Muscles taking part in quiet inspiration are – diaphragm, internal intercostals, external

intercostals, serratus posterior, levator costernum and scaleni. Muscles acting during deep inspiration are – sternomastoid, tarpezius, pectoral, rhomboids, serratus anterior and dilator nasi. During forced inspiration muscles of abdominal wall involved are rectus, oblique and transversus, abdominus quadratus lumborum and serratus posterior inferior Thus movement of thoracic cage assisted by different inspiratory and expiratory muscles helps the respiratory system in its vital act of ventilation along with diaphragmatic up-down movement (72). Rate and rhythm of activity of this system is finely and effectively regulated through different respiratory centers located in brain and nerve fibers. To maintain the adequate efficiency, respiratory system is provided with mucosal glands and surfactants. Normally in healthy individuals, respiratory system is functioning slightly at lower grade, keeping respiratory reserve in balance that can be utilized in emergency. Respiratory functions vary according to age and sex.

This highly efficient and sensitive respiratory system becomes vulnerable with profound changes during pregnancy (an altered physiologically normal state) where adaptability is a key feature to combat stress, anxiety and fear resulting in increased performance of all systems to meet demands.

The respiratory centers are situated in pons and medulla oblongata. It sends impulses through corresponding nerves, thus diaphragm along with intercostal muscles are stimulated. Respiration is also governed by concentration of carbon dioxide and hydrogen ion in blood bathing the respiratory centers. When concentration of these increases, respiratory rate is altered. This is important in studying effect of progesterone on respiratory centers During inspiration diaphragm goes slowly down, there is upward and outward movement of ribs and increase in all vertical, transverse and anteroposterior diameters of chest. Intrapleural pressure remains always negative while that in abdomen changes both sides i.e. negative and positive during expiration and inspiration respectively. In normal healthy conditions respiration takes place at rate of 14 to 18 per minute and amount of air used is about 6 to 8 liters.

Functions of respiration in normal are viz. to gaseous exchange, metabolic functions, excretion, acid-base balance, body temperature regulation, modification of cardiovascular system activities, etc. These are the functions that respiratory system has to perform during normal state while during pregnancy there is increased demand of fetal salvage and respiratory system has to deal with new condition of stress.

Physiology of Pregnancy

Nature has gifted reproductive systems to all living beings to ensure the perpetuation of own entry. In lower animals and organisms there is asexual reproduction that is carried out by simple division. In higher animals reproduction becomes sexual where males and females are different that keeps on organizing with evolution of higher species. The disadvantage of sexual reproduction is that it gives rise to variety in characteristics of individuals. Thus no individuals are alike in each respect.

Human beings are highly developed and highly encephalized living beings in whom the reproductive system is optimally developed. In human beings, reproductive life starts at the onset of puberty – adolescent age in males and females and terminates at menopause in females. Therefore, reproduction is possible only during reproductive age. Human beings are unisexual where each partner produces separate sex gametes at regular interval following biorhythm. Mature sex gametes from both partners can be fused and ovum (female gamete) can be fertilized after an act of coitus. Fertilized egg develops inside the uterus as an embryo and fetus for about ten lunar months of gestation period i.e. pregnancy. At end of which the infant is born through

parturition and cared by parents which includes the process of lactation in females.

Pregnancy starts when the female conceives as a result of fertilization of ovum by spermatozoa after an act of coitus and in certain cases after artificial insemination. This state of pregnancy gradually advances with physiological changes in mother normally up to ten lunar months, which is maintained by different hormones like gestagens, human chorionic gonadotrophins, estrogen and other placental hormones.

Gestational Respiratory Physiology

By the end of third trimester, the average circumference of the maternal thoracic cage has increased by 5 to 7 cm, which is, brought about by relaxation of the ligamentous attachments of the ribs and increased mobility of the sterno-manubrial joints. This includes both transverse and anteroposterior diameters. The substernal angle increases from 68^0 to 103.5^0 causing flaring of the ribs. These changes compensate for a diminution in the vertical diameter of thorax, which reaches approximately 4 cm because of the upward pressure exerted on the diaphragm and the rib cage by gravid uterus. This elevation is associated with a diminished height with in the pleural cavities. Whole effect is nullified by an increase in the width of the thoracic cage (56).

Capillary engorgement throughout the respiratory tracts results in mucosal edema and hyperemia, especially in the nasopharynx and tracheobronchial tree. In many pregnant women, the false vocal cords and arytenoids region of the larynx appear swollen and red, occasionally producing changes in voice and making nasal breathing more difficult especially at term. Nasal bleeds are also more frequent, especially when respiratory tract infection occurs concomitantly.

Lung excursion measured under fluoroscopy appears normal throughout gestation. Roentgenograms show increased lung markings stimulating a mild congestive lung failure because of increase in the vascular engorgement of the pulmonary tree.

Pregnancy causes many visible and invisible changes in human body. Changes in maternal lung function appear to be related to three major factors – progressive enlargement of the uterus, increase of progesterone hormone and increase of blood volume and blood flow (12).

Progressive enlargement of the uterus producing upward displacement of diaphragm demands for increased quota of oxygen and there is extra load of clearing fetal metabolites on renal and respiratory system.

Increased concentration of gonadal hormones like progesterone, estrogen and chorionic gonadotrophins also play their part. Increase in especially of progesterone level is a mild respiratory center stimulant that causes increased irritability of respiratory centers and makes them more vulnerable to pCO_2. It relaxes smooth muscles of bronchi and intercostal muscles. This causes increase in transverse diameter of chest Consequently total thoracic circumference increases by about 6 cm at term. Progesterone has some pyrogenic effect on body temperature, which has some role in elevation of respiratory rate. This effect is further intensified with increase thyroid activity during pregnancy and results in increase secretion of thyroxin, increase in basal metabolic rate and increase in body temperature and increase in respiratory rate.

Increase in blood volume and flow is to meet the increased requirement for fetus, placenta, uterus, breast tissue, and respiratory and cardiac function.

As a sum effect of all these factors during later months of pregnancy at full term, there is increased oxygen utilization of about 20% and to supply oxygen demand, minute volume is increased to about 50%. This demand is met with by increase in respiratory rate because growing uterus presses upon the dome of the diaphragm and hence there is decrease in

diaphragmatic movement (45) so respiratory rate is increased and shortness of breath is felt.

Several physiological, biochemical, anatomical and hormonal changes that occur during pregnancy are mostly the result of complex interaction with endocrine and uterine functions. During such changes in pregnancy, body requires an adequate supply of oxygen, nutrients and energy to fulfill the metabolic demands for new dynamic state. These changes will keep mother health fit for gestational period as well as postpartum and it helps to fulfill demands of fetus. Failure of such changes partially or fully may result in ill health of mother or and of fetus (infant) and at times may be fatal as well. All these changes are slow and gradual during pregnancy for good adaptation.

Pulmonary Function Tests

Highly sensitive respiratory system becomes most vulnerable with profound changes in its functions during pregnancy, so it becomes essential to know and to understand the alteration in functions of pulmons during pregnancy. To study the functional aspects of respiratory system, group of functional tests can be performed which are broadly classified as dynamic and static lung functions.

Objectives of the present study

Until now, most of the pulmonary function tests have been carried out during expiration. In this study, attempt has been made to evaluate pulmonary function tests during normal pregnancy both during inspiration – that is an active process and reveals more about the restriction of pulmons as well as during expiration – which provides more information about obstructive state of pulmons. For this inspirogram and expirogram were taken, evaluated and analyzed in normal pregnant and normal nonpregnant subjects. First time attempt was made by the researcher of this work in 1982 to analyze the inspirogram and its related parameters and the research work was awarded S. S. Mishra Memorial Award by National Academy Of Medical Sciences, India. Present study is extension and elaboration of earlier awarded study. Additionally, inspirogram and expirogram parameters were compared to find obstructive and restrictive aspects of respiration during three trimesters along with nonpregnant state. Respiratory functions affected as a result of allergens due to industrialization in urban areas are of physiological interest in management of pregnant woman. Deviation of values of various parameters of pulmonary functions from those of norms during pregnancy guides the clinicians to treat accordingly. Apart from this knowledge of pulmonary

parameters, it is also helpful to the anesthetist in caesarian section and in any operative measures during pregnancy.

The diagnosis of precise nature and etiology of chronic pulmonary condition is not possible to a large extent even with elaborate diagnostic procedures involving examination of sputum, bronchoscopy, radiological examination and dermal hypersensitivity studies. However, pulmonary function test holds a key position in this list of diagnosis as well as prognosis and may detect chronic obstructive airway disease before clinical features develops. Therefore, the detailed study of pulmonary function tests will enable us to understand the specific changes, leading to certain abnormal findings during pregnancy.

Clinical studies have been made to appraise the inference of normal pregnancy on some pulmonary functions of respiratory system by some workers in India. The results and available data are controversial. So in this study, an attempt has been made to standardize the various pulmonary function tests during three trimesters of normal pregnancy, as they are likely to be affected differentially.

Though India is a developing and an advancing country in the field of reproductive physiology, pulmonary function tests during pregnancy allocate lions share of research work

even today especially in parameters like tidal volume, respiratory rate, respiratory minute volume, expiratory reserve volume, inspiratory reserve volume, inspiratory capacity, vital capacity, timed vital capacity and maximum voluntary ventilation but parameters of inspiratory flow rates and respiratory efficiency tests have less contribution in respiratory research literature.

Most of the available literature relating to pulmonary function is in pathological respiratory disorders. Even though the same work has been carried out during pregnancy but is more on pregnancy with complications. Physiological changes observed in various cardiopulmonary parameters that might prove to be reasonable screening technique for unexpected abortions and other complications of pregnancy. Moreover scattered information and dearth of literature regarding many parameters created interest. Insufficient literature is available on maximum inspiratory and expiratory flow rate parameters during pregnancy. Inapt mention of respiratory reserve and breathing reserve ratio has been there in published literature during pregnancy. Researcher has not come across the published literature on respiratory efficiency tests as breath holding test, maximum expiratory effort (pressure) test and 40 mm Hg endurance test in pregnancy that is a physiological adaptive state. Except the few studies the researcher of

present study has not come across any other published work of respiratory flow rates specially the inspiratory during pregnancy.

In present study, first time an attempt has been made to find maximum inspiratory flow rate, maximum expiratory flow rate, finding their ratios (to confirm the status of respiratory condition), respiratory reserve, breathing reserve ratio and respiratory efficiency tests during normal pregnancy.