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شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

بسم الله الرحمن الرحيم

ARTERIAL OXYGENATION AND HEMODYNAMIC CHANGES DURING THORACIC SURGERY

THESIS

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INTRODUCTION

MECHANISM OF RESPIRATION

Introduction :

Gases are exchanged between the blood and air through the walls of the alveoli. Blood and air in the lungs must be continuously renewed in order to maintain efficient conditions to this exchange. Air is renewed by thoracic and pulmonary expansion causing inspiration which is an active process, and passive retraction causing expiration.[1]

Bony structure of the thorax :

The bony structure of thoracic cage is formed of thoracic vertebrae, the ribs and the sternum. The thoracic vertebrae articulate with the ribs by two joints. The rib has only one movement, that of rotation around its axis. The anteroposterior and transverse diameters of the chest are increased during inspiration. The sternum moves with the ribs, it projects upward and forward during inspiration. The anteroposterior diameter is increased by elevation of the ribs, and upward and forward movement of the sternum, while the transverse diameter is increased by winging of the ribs during their elevation.[1]

Respiratory Muscles

(A) Inspiratory muscles :

(1) The diaphragm :

The diaphragm is the principal inspiratory muscle and it can main adequate respiration when all other muscles have been paralyzed. It accounts for 15% of thoracic volume changes. The diaphragm is attached

all around the circumference of the lower thoracic cage separating the abdomen from the thorax. It is innervated by the phrenic nerves (C_3-C_5).

The diaphragm is arched upward due to the negative intrathoracic pressure and abdominal pressure is an accessory factor. Contraction of the diaphragm pulls it down, lengthens the vertical diameter of the thorax.[2]

(2) The external intercostal muscles :

In normal inspiration the ribs are raised mainly by the contraction of external intercostals. The muscles are inserted on two contiguous ribs, the fibers have a forward and downward direction. Its contraction leads to elevation and evertion or winging of the ribs and thus increases the anteroposterior and transverse diameters of the thoracic cavity. These muscles are innervated by the intercostal nerves (Th 1-11 segments).

(3) The accessory inspiratory muscles :

Act only in deep inspiration, (eg) sternomastoid, serratus anterior and posterior and scaleni muscles.[2]

(B) <u>Expiratory muscles</u> :

In normal quiet breathing expiration is mainly passive. These muscles are active only during forced expiration. They are the abdominal wall muscles, contraction of that muscles compresses the viscera and raises the diaphragm.[2]

Intrapleural or Intrathoracic Pressure

The pleural sac is a potential cavity. Normally there is a thin layer of fluid between the visceral and parietal pleura. The lungs slide easily on the chest wall, but resist being pulled away from it.

the intrapleural pressure is about (-3) mmHg (relative to atmospheric), during normal expiration and (-6 to -10) mmHg during normal inspiration.

This negative pressure is due to :-

(1) The elasticity of the lung.

(2) The rigid chest wall opposes the elasticity of the lungs.

(3) The thoracic cage is larger and more developed than the lungs.[3]

Intrapulmonary Pressure

The lungs are connected to the atmosphere by the air ways. So, the intrapulmonary pressure in midthoracic position at the end of inspiration and expiration is atmospheric, (zero pressure). In normal breathing the air passes in and out of the lung as a result of the rhythmic changes in the intrathoracic pressure. The intrapulmonary pressure becomes negative (-2) mmHg, during inspiration due to distension of the lung so air passes in the lung.[3]

At the end of inspiration pressure becomes zero. During expiration the lung collapses before air passes out of it. So the pressure rises to 2

mmHg above atmospheric. This allows air to pass out of the lung. At the end of expiration of the pressure becomes zero again.[4]

Transpulmonary Pressure

It is the pressure difference between the alveolar or intrapulmonary pressure and the pleural pressure.[3]

Compliance of the Lung's and Chest Wall

Compliance is the change in volume of the lung per unit change in transpulmonary pressure

Both the lungs and thoracic cage are elastic structures.

The elastic forces of the lung can be divided into :-

(1) The elastic forces of the lung tissue itself which are determined mainly by the elastic and collagen fibers of the lung parenchyma.

(2) The elastic forces caused by surface tension in the alveoli which account for about 2/3 of the total elastic forces of the lungs.

It is to be noted that the compliance of the lungs and thoracic cage together is one half that of the lung alone. Compliance of the lung alone is about 250 ml/cm H_2O while compliance of the lung and chest is about 125ml/H_2O .[4]

The relationship of the lung volume to the intrapleural pressure is plotted as a curve.

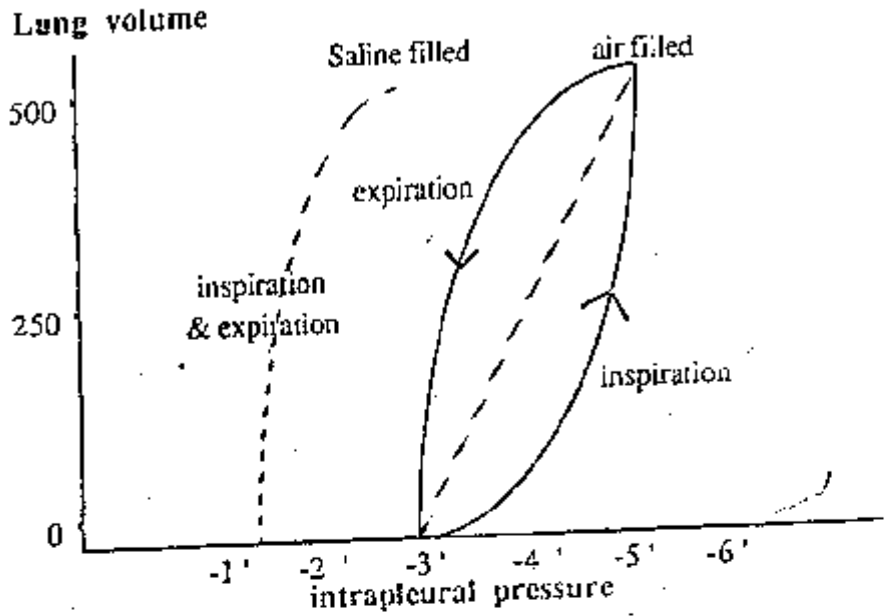

Fig.(1) : Pressure volume relation in lung during inspiration and expiration by air and saline

Factors affecting lung compliance :

(1) The curve is shifted downward and to the right. This means decreased compliance in the following conditions : Pulmonary congestion, lung fibrosis, deformitis and diseases of the thoracic cage.

(2) The curve is shifted upward and to the left when the compliance is increased eg. emphysema.[4]

WORK OF BREATHING

The total work of normal breathing ranges from 0,3 up to 0,8 kg/m/minute.

The value rises markedly during exercise, it can increase as much as 50 folds.[5]

The work is performed by the respiratory muscle for :

(1) Elastic work of
- The chest wall
- Lungs
- Antagonises the surface tension by the fluid lining the alveoli.

(2) Tissue resistance work, moving the inelastic tissues to expand the thoracic cavity.[5]

Work of breathing is greatly increased in :

(1) Exercises.

(2) Emphysema.

(3) Bronchial asthma.

(4) Congestive heart failure.[5]

Normal Pulmonary Circulation

During the passage or red blood cells through the lungs, hemoglobin is normally oxygenated to nearly full capacity and the blood is cleaned of much particulate matters and bacteria. The lungs, in addition to functioning as a blood oxygenator and filter, play a dominant role in achieving an acid-base balance by excreting carbon dioxide, thereby, helping to maintain an optimal blood PH[6].

Pulmonary Circulation divided into :

A) Pulmonary arteries :

Pulmonary arteries accompany the branching conducting passages and are closely associated with them. These arteries are surrounded by loose connective tissue sleeves, in which, run a network of pulmonary lymphatic. Since the pulmonary arteries are not connected directly to lung tissue, major adjustments in length and caliber of arteries may occur independently of changes in lung volume and intrapleural pressure. The media of the main pulmonary artery has a thickness one-half that of the aorta and its elastic fibers are shorter and less well organized. Smaller pulmonary vessels analogues to arterioles in the systemic circulation posses well developed media but lack appreciable smooth muscle.[7]

While no valves are present in the bed, the vessels do possess both sympathetic and parasympathetic fibers whose functional significance is not clear.[8]

It is apparent, however, that this nerve supply is considerably poorer than that of the systemic circulation, that the cholinergic is distinctly less than the adrenergic innervation, and that stimulation of the pulmonary sympathetic changes the distensibility characteristics of the large elastic vessels rather than the flow-resistive properties of the small muscular pulmonary arteries.[9]

As a consequence of its thin wall, sparse smooth muscle elements, lack of valves, and major autonomic innervation, the bed is so distensible that resistance to pulmonary blood flow is negligible in comparison with systemic vascular resistance, and intravascular pressures are quite low.[54]

Therefore, the pulmonary arteries have the ability to accommodate most of the stroke volume of the right ventricle.[7]

B) Pulmonary veins :

Pulmonary veins are located between lung lobules unlike the arteries, which are associated with the airways. Walls of the pulmonary veins lack smooth muscle. Some anastomosts have suggested the presence of functional sphincters at the junctions of pulmonary veins and left atrium but the significance of them, if present, is not known.[7]

The pulmonary venous system, although surrounded by connective tissue sleeves throughout its course, lacks perivascular lymphatic channels.

Since the venous circumvascular connective tissue is attached directly to the lung parenchyma, pulmonary venous caliber is influenced to a large extent by alterations in lung volume.[7]

Pulmonary Ventilation

Respiratory cycle :

During rest the person breathes 12 to 16 times per minute. Each respiratory cycle consists of inspiration and expiration.

Inspiration is immediately followed by expiration, during which the thoracic volume decreased to its original position.

Expiration takes usually a longer time than inspiration and expiration pause is found before inspiration of the next cycle.[10]

Normal pulmonary ventilation or respiratory minute volume :

The respiratory minute volume is obtained by multiplying the tidal volume by the respiratory frequency. It is about 6-8 liters per minute. It increases when the frequency of respiration increases or the tidal volume becomes larger.

To determine the alveolar ventilation, the dead space corresponding to each respiratory movement must be substracted from the total ventilation.

Tidal volume is the air entering and leaving the lungs in a respiratory cycle. Tidal volume is about 500 ml.[10]

Respiratory cycle :

The rate of respiration is influenced by age, sex, size, height, work and rest, sleep etc.