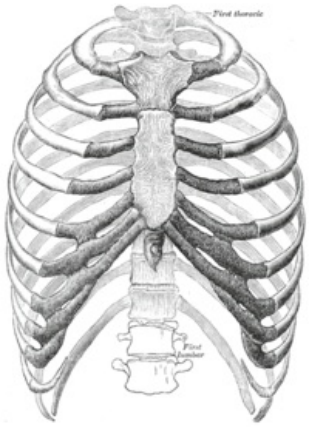
Movements of the thoracic cage

The rib cage:

1. provides protection for thoracic organs and tissues against external mechanical forces exerted on the chest
2. provides the only way through which respiration can occur



The human rib cage

Protection

The thoracic rib cage protects the heart and the lungs, the two organs that are of vital significance for the maintenance of the appropriate homeostatic internal environment necessary to sustain life. The rib cage consists of the sternum and the ribs with the latter being attached on the thoracic region of the vertebral column between T1 and T12 vertebrae. The anatomical and physical arrangement of the components of the rib cage besides being very strong, they are also very flexible absorbing and evenly redistributing any mechanical force applied on the chest walls.

Respiration

a. Inspiration

The inspiratory process involves:

- Pleural pressure: the pressure that prevents the lungs from collapsing accordingt to the elastic compliance of the lungs.
- Alveolar pressure: the pressure that induces air inflow inside the lungs
- Transpulmonary pressure: the pressure difference between pleural and alveolar pressure is called transpulmonary and indicates the inspiration difficulty level
- Inspiratory muscles: receive stimulation from the dorsal respiratory group and pneumotaxic center in brain stem inducing contraction and relaxation respectively

The inspiratory sequential process:

- The inspiratory muscle contract in order to lift the rib cage laterally and up against the gravitational field increasing the thoracic cavity volume. The inspiratory muscles are: external intercostals, sternocleidomastoid, scalene and most importantly the diaphragm
- This increase in volume tends to drive the pleural pressure towards more negative pressure values
- In turn, the pleural pressure is the driving force of the alveolar pressure which during inspiration tends to have a negative pressure value in order to draw air inside the lungs
- as soon as the the alveolar pressure becomes negative in respect to the external atmospheric pressure, then air flows inside the lungs tending to equalize the difference between the two pressures

b. Expiration

The expiration process: during resting conditions is an entirely passive process driven by:

- relaxation of the inspiratory muscles
- gravitational pull of the rib cage downwards reducing the thoracic cavity volume
- lung elastic recoil against stretching

The expiratory sequential process:

- during the end phase of inspiration, stretch receptors in the lung walls inform the brain stem about the distension level of the lungs. When these levels rise at a certain level, they induce a reflex through which the pneumotaxic center in brain stem inhibits the inspiratory stimulating activity of the dorsal respiratory group giving rise to the passive expiration process
- the passive expiration tends to decrease the volume of the thoracic cavity
- decrease in the volume induces rise of the pleural pressure towards the less negative levels
- less negative pleural pressure causes the increase of the alveolar pressure and along with elastic compliance of the lungs, they constitute an alveolar pressure of positive value in respect with the atmospheric pressure
- this difference between the two pressures induces air being expelled from the lung

The expiration during exercise: the expiration during exercise ceases being a passive process and become an active one. This chance is necessary to provide forceful and quick expiration in order to increase the minute ventilation rate and oxygen consumption. The steps towards active expiration are:

- the ventral respiratory group in the brain stem receive afferents from the chemoreceptors of the cardiovascular system transmitting information about the oxygen requirement status of the body.

- the ventral respiratory group during resting conditions is inactive in contrast to the dorsal group. The VRG controls the contraction of the expiratory muscle in order to decrease the thoracic cavity volume as soon as possible.
- the expiratory muscles are the internal intercostals and the abdominal muscles

MOVEMENTS OF RIBS

Movements of ribs depends on the orientation of *Costo*-vertebral and *Costo-transverse* joints which are present on the thoracic vertebral bodies.

Pump handle movement

- upside down movement; closely related to the movement of pump-handle
- mainly contributes to the movement of upper ribs
- as the Orientation of costo-vertebral and costo-transverse joint is closely related to saggital plane the upside down movement of ribs occurs whic is called as pump handle movement

Bucket handle movement

- mainly the movement of lower ribs
- because the lower costo-vertebral and costo-transverse joint is related to frontal plane thus bucket handle movement occurs.

Links

Bibliography

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