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Motors muscles of ventilation

Plan

I- INTRODUCTION
A- The diaphragm
II- ACCESSORY RESPIRATORY MUSCLES
A- The intercostal muscles
B- Internal thoracic muscles
C- External thoracic muscles
D- Back muscles
III- Phrenic nerve

Objectives

- know the general organization of the diaphragm
- know its different portions
- know the orifices of the diaphragm and their contents
- know the accessory muscles of ventilation

I-INTRODUCTION

The muscles that drive ventilation are muscles with constant contraction. Some are respiratory muscles like the diaphragm, which is the main respiratory muscle; others act on the movements of the thoracic cage and accompany breathing. These are the respiratory muscles

accessories.

A- THE THORACO-ABDOMINAL DIAPHRAGM

1- Definition

The diaphragm is a muscle with rhythmic and permanent contraction enabling breathing. It forms a musculo-tendinous partition separating the thoracic and abdominal cavities, allowing only a few nerves, the esophagus, and a few vessels to pass.

2- Descriptive Anatomy

2-1- Shape and Location

The diaphragm is located below the lungs. It has the shape of a dome with two cusps on the right and left with an upper convexity. The right dome is higher than the left.

2- 2- Projection

On expiration, the right dome corresponds to the 4th intercostal space, and the left dome corresponds to the 5th intercostal space. On inspiration, the domes descend by two intercostal spaces. The median part of the dome corresponds to the xiphoid process.

Breathing muscles

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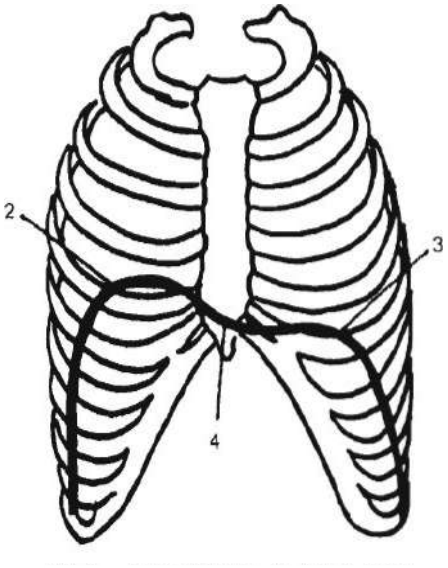
1- Dome
Diaphragmatic (CD) horizontal part

2- Right CD

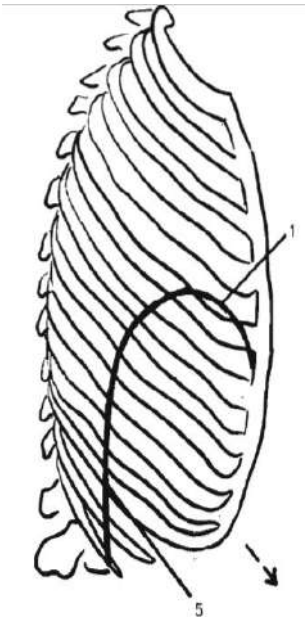
3- Left CD

4- Tendinous center

5- Dome
Vertical diaphragmatic part



Anterior view of the thorax



Lateral view of the thorax

2-3- Anatomical constitution

The diaphragm is a set of digastric muscles whose intermediate tendons are gathered at a single tendinous center called the phrenic center. The muscular peripheral part attaches to the skeleton of the thoracic cage, ventrally and laterally, and to the lumbar spine dorsally. Thus, within this muscular assembly, located at the periphery, there is a lumbar part (lumbar), a chondro-costal part and a sternal part.

a- The phrenic center

The phrenic center is the central part of the diaphragm, a very resistant, transversely elongated, three-leaf clover-shaped tendinous sheet, with a anterior (ventral) leaf and two lateral leaves, right and left. At the level of the right lateral leaf, the orifice of

the inferior vena cava, which is bordered by two semicircular bands, a superior and an inferior.

b- Peripheral part of the diaphragm

The peripheral portion of the diaphragm presents three portions, lumbar, chondro-costal and sternal.

b-1- lumbar or vertebral portion: vertical, in this part, on either side of the midline two parts are distinguished: a medial and a lateral part.

- The medial part: it represents the pillars of the tendinous and muscular diaphragm.

➢ **Tendinous pillars**

The tendinous pillars are inserted on the ventral surface of the lumbar spine.

-The right pillar, traditionally more developed than the left, extends from the 1st to the 3rd lumbar vertebra lumbar and on the corresponding intervertebral discs.

.-The left pillar is less thick, it is attached from the 1st to the 2nd lumbar vertebra and on the disk corresponding intervertebral disc.

The two pillars come together to delineate, in front of T12, a solid and inextensible tendinous arch, the median arcuate ligament, which is traversed by the aorta, which, from thoracic, becomes abdominal. It will travel along the left flank of the lumbar spine, behind it accompanied by the thoracic (thoracic) duct.

➢ **Muscular pillars**

Continuing from the tendinous pillars in a cranial and ventral direction, the fleshy fibers of the muscular pillars quickly increase in volume. Two muscular bundles go from one pillar to the other and cross over

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the midline lines delimit the esophageal orifice opposite Th10, where the esophagus and vagus nerves pass (pneumogastric nerves).

- The lateral part

This is the medial arcuate ligament, each ligament is a tendinous arch uniting the vertebral body of L1 to its transverse process. It passes above the psoas major muscle.

b-2 - Costal portion

The diaphragm attaches to the cartilage of the 7th, 8th and 9th ribs and to the bony part of the 10th, 11th and 12th ribs. We find:

The lateral arcuate ligament (arcade of the quadratus lumborum) is located outside the medial arcuate ligament (arcade of the psoas) stretched between the transverse process of L1 and the summit of the 12th rib. The accessory arcuate ligament stretched between the 10th and 11th ribs, and between the 11th and 12th ribs.

b-3- Sternal portion

It originates from the posterior surface of the xiphoid process to the anterior foliole. Two lateral gaps are the costoxiphoid hiatuses (Larrey slits) and a median opening, the retro-xiphoid hiatus (Marfan slit).

1- Xiphoid Appendix

2- Sternal part

3- Anterior foliole

4- Esophageal hiatus

5- Median arcuate ligament

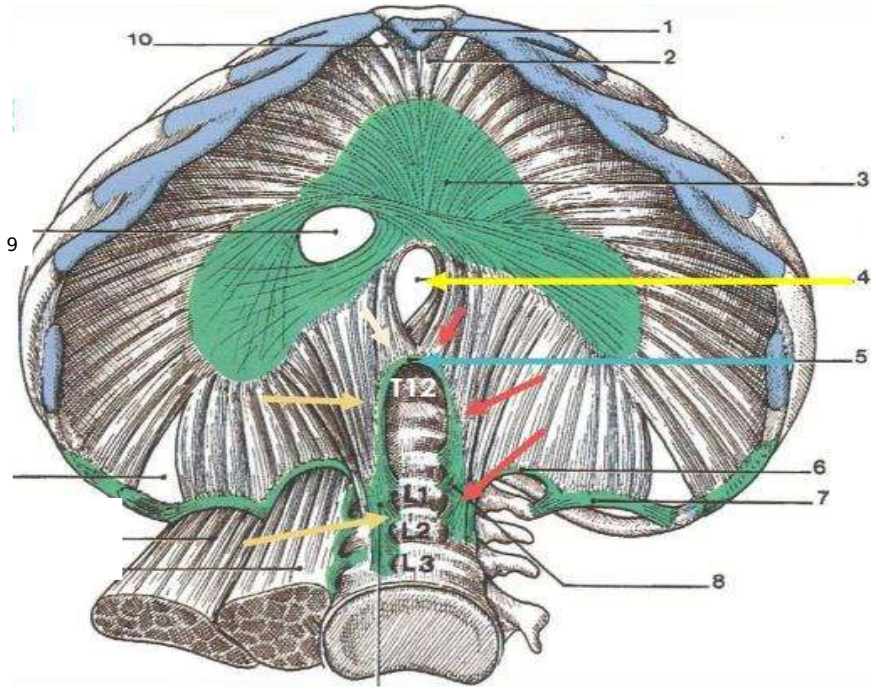
6- Medial arcuate ligament

7- Lateral arcuate ligament

8- Left pillar

9- Inferior vena cava orifice

10- Larrey slit



Inferior view of the diaphragm

c- DIAPHRAGMATIC OPENINGS

c-1- Main openings or hiatuses

-Aortic orifice (hiatus): projects to T12, fibrous and inextensible, affords passage to the aorta accompanied by the thoracic duct.

- Esophageal orifice (hiatus): projects to T10, muscular and extensible, affords passage to the esophagus and the two vagus nerves (pneumogastric nerves).

- Inferior vena cava opening (hiatus): projects to T9, fibrous and non-extensible, affords passage to the inferior vena cava.

c-2- Accessory openings

- Medial hiatus, between the main pillar and the accessory (when present), passage to the greater splanchnic nerve, on the right to the azygos vein and on the left to the hemiazygos vein

- Lateral hiatus, between the accessory pillar and the medial arcuate ligament, passage to the lesser splanchnic nerve, inferior splanchnic nerve and the sympathetic chain

- Retrosternal hiatus (Marfan gap): avascular
- Costoxiphoid hiatus (Larrey fissures): passage of the internal thoracic artery
- Openings of the intercostal nerves.

3- BLOOD VESSELS AND NERVES

a-ARTERIES

-Inferior phrenic arteries, arise from the abdominal aorta at the level of T12.

-Superior phrenic arteries, arise from the internal thoracic artery.

b- VEINS

Roughly aligned with the arterial system.

c-LYMPHATICS

Two networks:

Subperitoneal toward the para-aortic lymph nodes.

Subpleural toward the sternal and posterior mediastinal nodes

d-NERVES

Phrenic nerves, right and left. They arise from the cervical plexus. They are the motor nerves of the diaphragm.

4- ACTION

During inspiration

The diaphragm contracts, flattens, and the central tendon lowers; this increases the vertical diameter of the thorax. The viscera are pressed, pushing the abdominal muscles forward. Under the action of the intercostal muscles and the scalene muscles, the ribs raise, lifting the thoracic cage and pushing the sternum forward. The anteroposterior and transverse diameters of the thorax then widen, the intrathoracic pressure decreases, causing external air to be drawn in. It results in the penetration of

air into the lungs.

Upon expiration

The movements reverse

Respiratory muscles that drive ventilation

II- ACCESSORY RESPIRATORY MUSCLES

These muscles are divided into three groups

- **Thoracic respiratory muscles**

A- The intercostal muscles

They are located in each intercostal space. These muscles are arranged in three layers, from the outside to the inside: the external, internal, and innermost intercostal muscles. There are eleven pairs of each, a total of 66 muscles.

1- the external intercostal muscle

It extends from the costotransverse joints to the costal cartilages where it continues as the external intercostal membrane. Each external intercostal muscle attaches at the lower edge of the superior rib on the external lip of the intercostal groove. Its fibers run from posterior to anterior and from top to bottom. It ends

on the superior border of the underlying rib. It is an accessory inspiratory muscle

2- the internal intercostal muscle

It extends from the sternum to the angles of the rib where it continues as the internal intercostal membrane. Its fibers run from the external lip of the groove of the superior rib, slanting downward and backward to end at the superior border of the inferior rib. It is an accessory expiratory muscle.

3- the innermost intercostal muscle

They are located in the middle part of the intercostal spaces.

It stretches from the internal lip of the groove of the superior rib, its fibers run downward and forward to end on the superior border of the inferior rib. It is an accessory expiratory muscle.

- Innervation

The intercostal nerves

- Action: they connect the ribs to each other and protect the interior of the thorax from atmospheric pressure. These are accessory respiratory muscles.

B- Internal thoracic muscles

1- Transverse thoracis muscle (triangular sternum muscle) A paired, flat and serrated muscle, forming the deep layer of the muscles of the anterolateral thorax wall. It connects the sternum to the costal cartilages.

Action: lowers the costal cartilages, it is a very accessory expiratory muscle.

C- External thoracic muscles

1- the elevatores costarum (superior rib elevators) They are triangular, originate from the apex of the transverse processes of vertebrae C7 to T11, and end on the 12 ribs. Innervated by the intercostal nerves.

Action: they are rib elevators and therefore inspiratory.

D- Back muscles

The intermediate back muscles, two in number, are thin and broad, united by an intermediate aponeurosis; they are the serratus posterio-superior and serratus posterio-inferior muscles. The serratus posterior superior is a rib elevator, inspiratory.

The serratus posterior inferior muscle is expiratory.

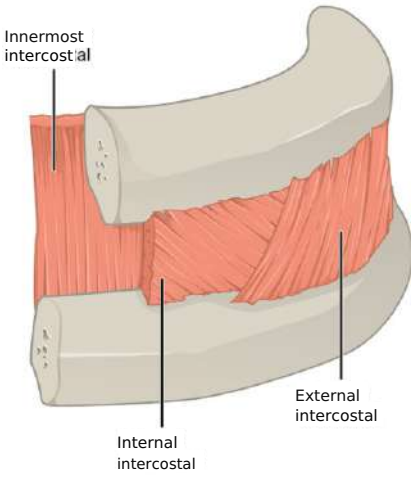
- **Cervical respiratory muscles**

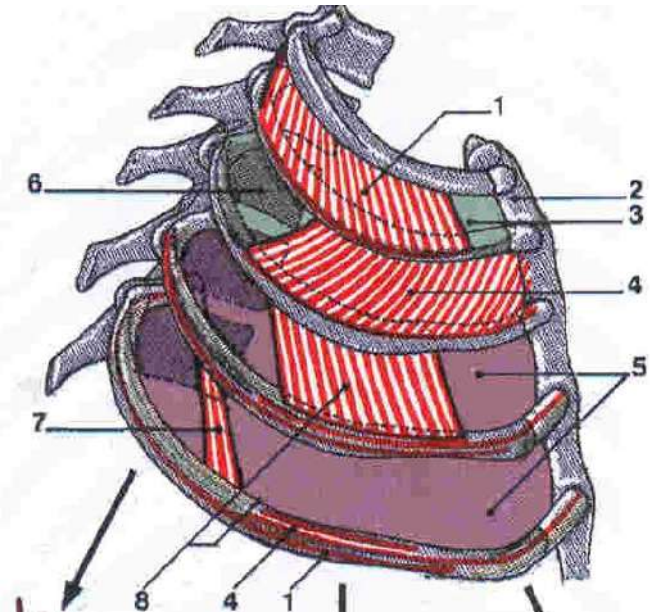
The sternocleidomastoid muscle, and the scalene muscles

- **Abdominal respiratory muscles**

The muscles of the abdominal wall (the rectus abdominis).

Breathing muscles





The intercostal muscles

1 : external intercostal muscle 3 : external intercostal membrane 4 : internal intercostal muscle

5 : endothoracic fascia 6 : internal intercostal membrane 8 : deep intercostal muscle

III- THE PHRENIC NERVE

The phrenic nerve mainly originates from the anterior root of C4 and, optionally, C3 and C5. It travels within the fascia of the anterior scalene. The phrenic nerves descend into the thorax and provide innervation to the mediastinal pleura and the pericardium. They end on the diaphragm,

providing its motor innervation.

Course

In the neck: the phrenic nerve courses along the anterior scalene muscle, it enters the thorax by passing between the subclavian artery and the subclavian vein.

In the thorax: The right phrenic nerve descends along the lateral surface of the superior vena cava. It passes in front of the right pulmonary pedicle and then descends vertically along the right lateral face of the pericardium to reach the diaphragm.

The left phrenic nerve runs along the left lateral surface of the pericardium with an oblique course anteriorly, and reaches the diaphragm somewhat behind the apex of the heart.

References

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View this course in video at this YouTube link

https://youtu.be/zVLqTUec2sM?si=rUvpDZcAAj3i4ktI