شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

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جامعة عين شمس

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قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HANAA ALY

INTRODUCTION

Nowadays, there are an increasing percentage of elderly, critically ill patients in Intensive care unit (ICU), who need mechanical ventilation support due to several different causes e.g. acute respiratory failure, shock and coma **(Flaatten et al, 2017).** Mechanical ventilation is being one of the most critical factors predicting both; short and long-term outcomes **(HSU et al., 2020).**

Although mechanical ventilation is life-saving for patients with acute respiratory distress, it causes weaning failures in approximately 20% of patients due to rapid deterioration of diaphragm muscle endurance and strength; this condition is called ventilator-induced diaphragm dysfunction (VIDD) **(Liu and Li, 2018).**

Weaning trials are usually started only after recovery or improvement of the underlying disorders that necessitated mechanical ventilation. Also, the patient should have an adequate gas exchange, well muscular and neurological status as well as hemodynamic stability (**Conti et al., 2004).**

Difficult weaning from mechanical ventilation could be defined as when patients cannot be weaned from mechanical ventilation within 7 days or requiring more than three effective spontaneous breathing trials (SBT) **(Boles et al., 2007).**

The longer the duration of mechanical ventilation, the higher rates of morbidity and mortality **(Pattarin and Sasithon, 2018).** So mechanical ventilation aid should be discontinued as soon as patient can take breathe spontaneously **(Blackwood et al., 2011).**

Diaphragmatic dysfunction (DD) is an essential cause of weaning failure. DD can occur as a consequence of infection, hypotension, hyperglycemia, hypoxia as well as mechanical ventilation **(Huang et al., 2017).**

Mechanical ventilation, even after a few hours, can cause DD by reducing the force of diaphragmatic contraction and hence spontaneous breathing **(Hooijman et al., 2015).** DD can be aggravated by disuse atrophy of both fast and slow-twitch myofibers of the diaphragm after administration of neuromuscular blocking agents **(Theerawit et al., 2018).**

Diaphragmatic activity and function during mechanical ventilation could be assessed by several monitoring tools such as electromyography, pressure-derived parameters, and ultrasound **(Schepens et al., 2020).**

Recently bedside ultrasound has a major role in the main aspects of critical illness management at ICU. It is a simple, accurate, reliable, non-invasive, cheap and non-hazardous tool for the assessment of many organs and structures **(Turton et al., 2019).** Various sonographic indices, such as diaphragmatic excursions and changes in diaphragm thickness during inspiration are used for assessing DD in various studies **(Boussuges et al., 2020) (Boussuges et al., 2019).**

To our knowledge, few studies discussed the important role of diaphragmatic ultrasound in an elderly patient **(Huang et al., 2017)** and concerned with study the relation between the diaphragmatic ultrasound indices and mechanical ventilation which are the main issues we concerned with and discussed in the present study.

AIM OF WORK

TO evaluate the role of ultrasonographic functional indices of the diaphragm in the weaning of mechanically ventilated elderly ICU patients and study the relationship between the ultrasonographic indices, time for mechanical ventilation and weaning time.

Chapter one

Anatomy and function of the diaphragm

Embryology of the diaphragm:

The diaphragm originates from 4 portions of the developing embryo: the septum transversum from the ventral portion, 2 pleuroperitoneal folds arising laterally and the dorsal mesentery (**Figure 1-1) (Robert, 2011).**

The septum transversum grows dorsally from the ventral body wall during the third to eighth week of gestation, providing the area of the diaphragm eventually apposed to the pericardial sac **(Schumpelick et al., 2000).**

Muscle fibers along with the neural structures that will form the phrenic nerves migrate from the third to fifth myotomes to lie between the membranes of the septum transversum and the pleuroperitoneal folds. The dorsal mesentery encompasses the developing vasculature and the digestive tract **(Schumpelick et al., 2000).**

Failure of closure between these portions can lead to residual defects. For example, a foramen of Bochdalek hernia can arise from failure of the pleuroperitoneal membrane to form a common aponeurosis with the developing transversus

abdominis between what will become the tip of the 12th rib and the quadrates lumborum **(Robert, 2011).**

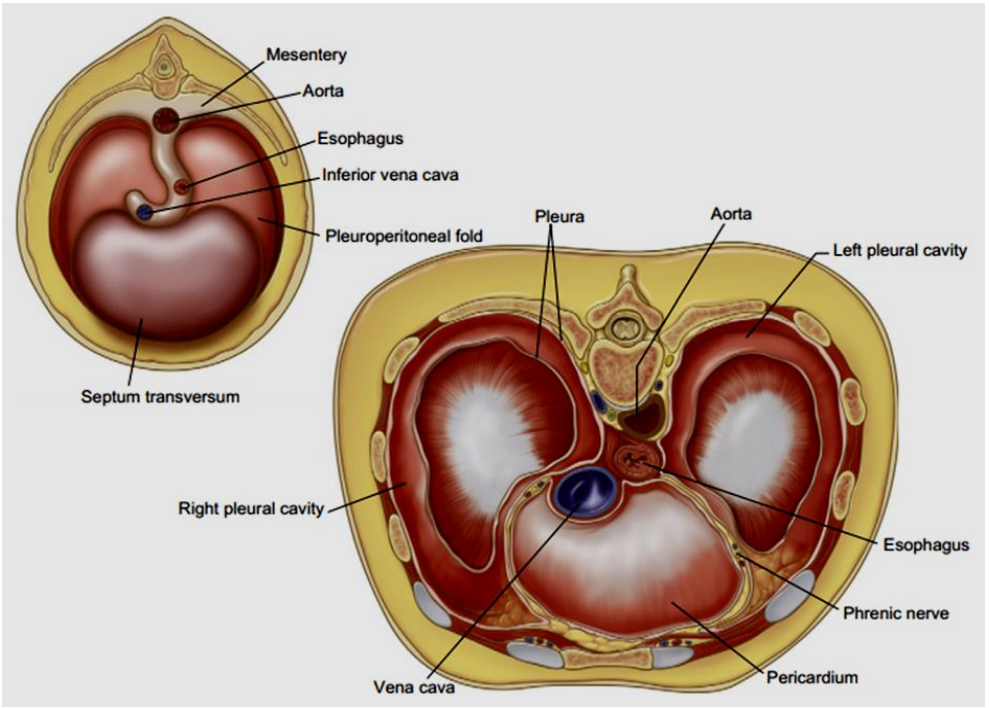

Figure (1-1) Embryologic components of the diaphragm **(Quoted from Robert, 2011).**

Diaphragmatic hernias occurring because of a failure of fusion of the membranes will give rise to a hernia without a sac. If the membranes fuse but the muscle fibers fail to migrate from the cervical myotomes, a hernia with a sac results **(Robert, 2011).**

Anatomy of the diaphragm:

The diaphragm is a dome-shaped musculotendinous structure that is very thin (2–4mm) and concave on its lower side and separates the chest from the abdomen **(Bordoni and Zanier, 2013).**

The central aponeurosis of the diaphragm has been considered to have the shape of a clover leaf with 1 anterior and 2 lateral leaves. The muscular portions attach to the central aponeurosis and to the circumference of the thoracic inlet (the ribs, the sternum, and the lumbar spine). There are 3 parts to the muscular portion of the diaphragm separated by areas without muscle; the lumbar, the costal and the sternal, each of which insert into the central aponeurosis of the diaphragm (**Figure 1-2**) **(Robert, 2011)**.

The medial and lateral arcuate ligaments act as a bridge between the thoracolumbar fascia posteriorly and the transversalis fascia anteriorly. In the phrenic center, the vena cava passes through an opening located anteriorly on the right **(Talasz et al., 2011).**

The superior diaphragmatic surface merges into the pulmonary pleura, whereas the inferior surface merges into the peritoneum **(Bordoni and Zanier, 2013)**.

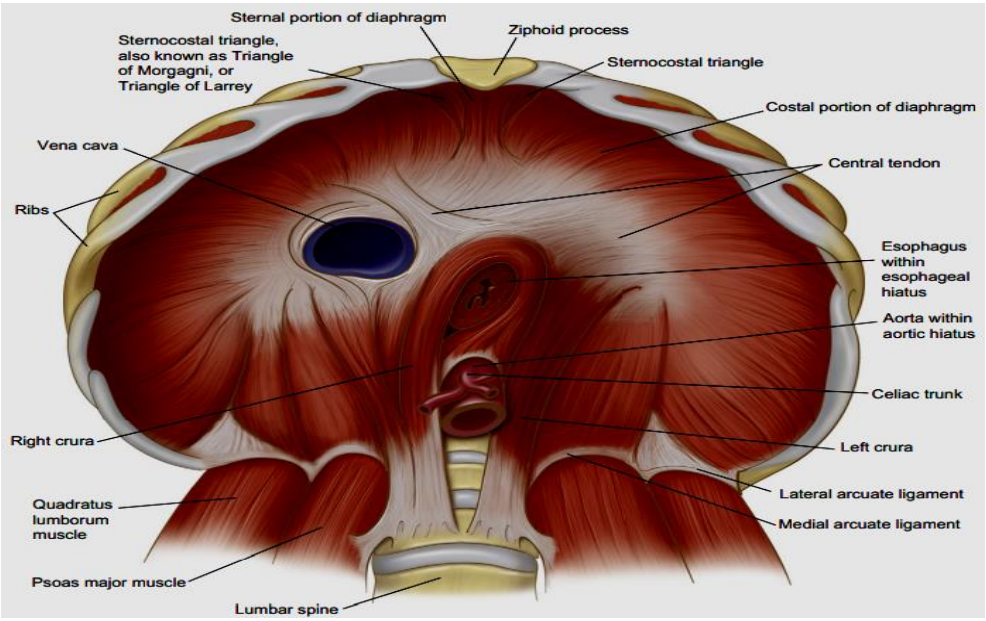

Figure (1-2): Abdominal view showing the lumbar, costal, and sternal portions of the muscular diaphragm **(Quoted from Robert, 2011).**

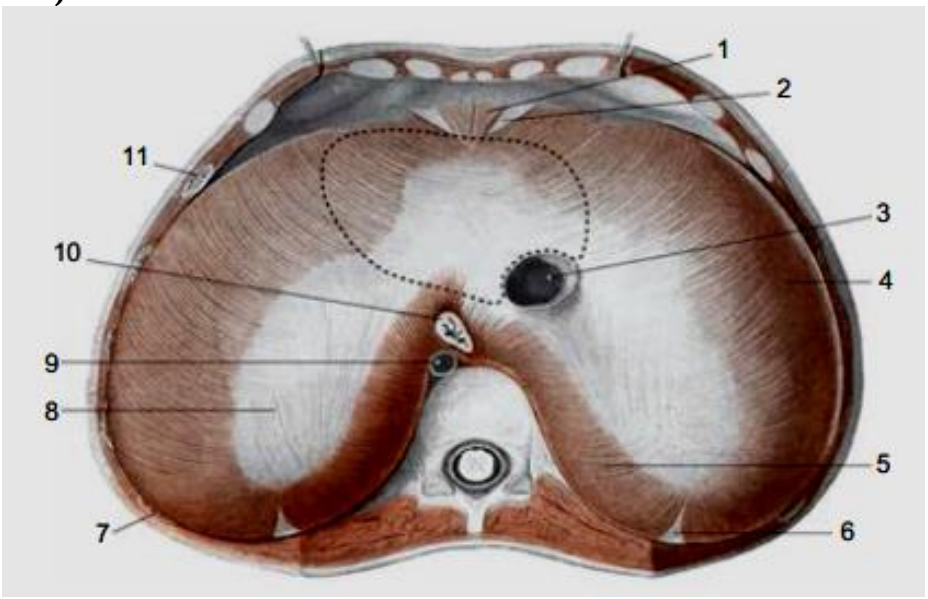

Figure (1-3): The area above the diaphragm: the dotted line for the support of heart 3: inferior vena cava; 10: esophagus; 9: aorta; 8: tendinous center; 5: lumbar area **(Quoted from Bordoni and Zanier, 2013)**.

Diaphragmatic ligaments:

The diaphragmatic ligaments are structures that connect the diaphragm to the viscera as:

- The inferior pulmonary ligament is a pleural thickening connecting the diaphragm to the base of the lungs.
- The phrenicopericardial ligament connects the diaphragm to the heart.
- The phrenicoesophageal ligament joins the esophagus and the diaphragm and is composed of loose connective tissue.
- The hepatic ligaments, the falciform ligament and the right and left triangular ligaments represent a subdiaphragmatic peritoneal thickening
- The phrenicocolic ligament connects the diaphragm to the angle of the right ascending colon.
- The ligament of Treitz is constituted by a series of muscular tracts that start in the main left pillar and go to the duodenojejunal angle **(Bordoni and Zanier, 2013)**.

From a functional perspective, two areas can be recognized in the diaphragm, the crural region and the costal region. The former is responsible for correct breathing, whereas the latter prevents gastroesophageal reflux. This separation has an anatomic function, these diaphragmatic areas must work at different times and with different innervations (**Figure 1-3) (Figure 1-4) (Mantilla and Sieck, 2011).**

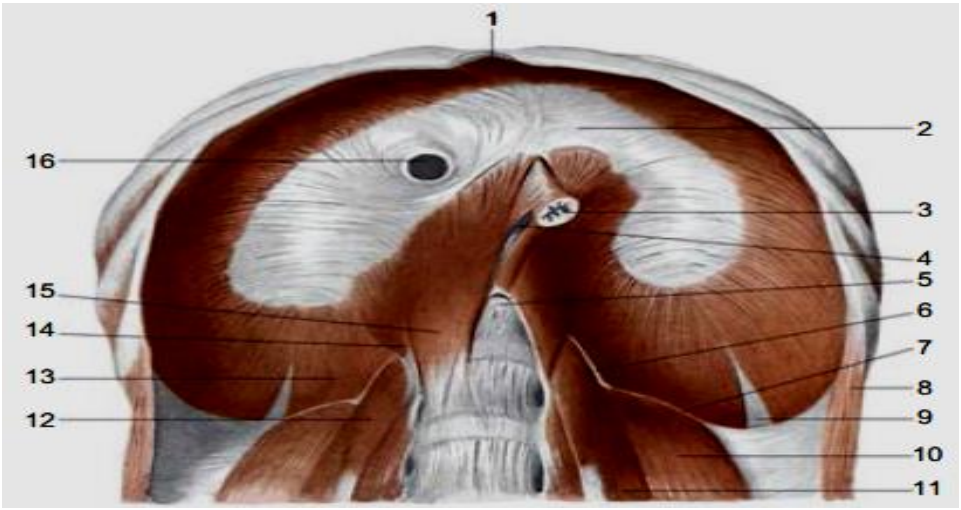

Figure (1-4): The sub-diaphragmatic area: 2: tendinous center or phrenic; 16: inferior vena cava; 3: esophagus; 5: aortic orifice; 15: medial pillar; 14: intermediate pillar; 13: lateral pillar; 6: medial arcuate pillar; 7: lateral arcuate ligament; 10: quadratus lumborum muscle; 11: psoas major muscle **(Quoted from Bordoni and Zanier, 2013)**.

The pelvic diaphragm not only has a significant role in supporting the pelvic organs and in resisting increasing pressure but also affects respiratory function **(Talasz et al., 2011).**

It also ensures the steadiness of the human trunk and maintaining urinary continence during respiration and coughing **(Mantilla and Sieck, 2011).**

Various studies have established that, before inhalation, electrical activity can be observed in the muscles of the pelvic floor and the same electrical activity is traceable for the transverse and oblique internus abdominis muscles **(Mantilla and Sieck, 2011)**.

Innervation of the Diaphragm:

Motor and sensory innervations are supplied by the phrenic nerve and the sixth or seventh intercostal nerves, the latter distributed to the costal part of the diaphragm.The muscular part of the diaphragm receives its main motor innervation via the phrenic nerve. The right and left phrenic nerves originate in the cervical plexus (mainly the fourth cervical nerve roots, with lesser contributions from the third and fifth roots) and run craniocaudally toward the diaphragm, passing anterior to the hilum of the lungs attaching to the pericardium along with the pericardiophrenic artery and veins where they provide pericardial branches. The right phrenic nerve descends along the superior vena cava, subsequently along the side of the pericardium anterior to the right pulmonary hilum then enters into the central tendon anterolaterally to the vena caval opening **(Figure 1- 5) (Anraku and Shargall, 2009)**.

The left phrenic nerve descends laterally to the side of the aortic arch and runs downward along the side of the pericardium, anterior to the left pulmonary hilum. There after, it enters into the diaphragm lateral to the left border of the heart and anterior to the central tendon. The phrenic nerves give branches on the thoracic side of the diaphragm**(Bordoni and Zanier, 2013)**.

The diaphragmatic branches of the phrenic nerves, however, are commonly embedded deep in the muscle and are not exposed on the undersurface of the diaphragm. Therefore, one cannot rely on visualization of those branches before incising the diaphragm **(Anraku and Shargall, 2009)**.

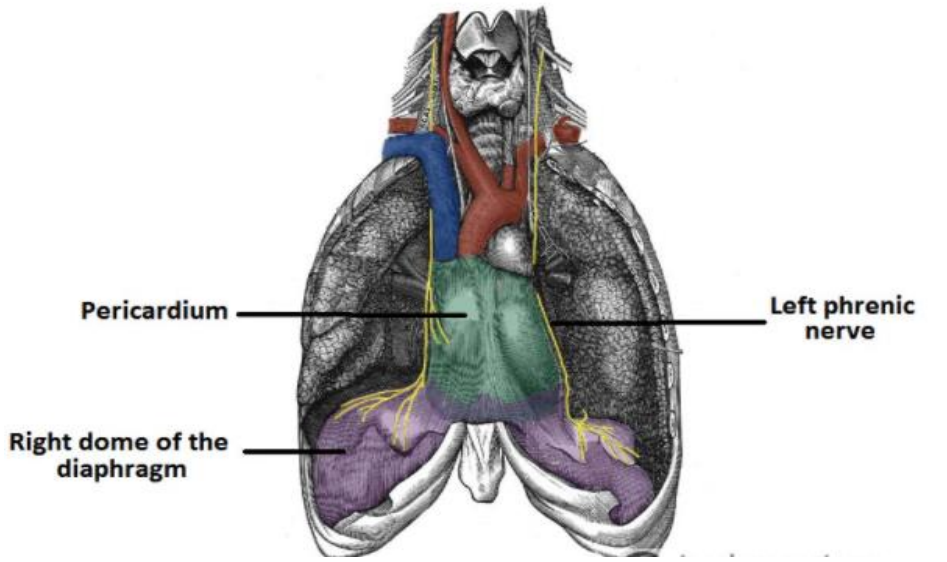

Figure (1-5): Innervation of the diaphragm **(Quoted from Anraku and Shargall, 2009)**.

Blood Supply of the Diaphragm :

Arteries and veins above and below the diaphragm supply and drain blood. From above, the diaphragm receives blood from branches of the internal thoracic arteries, namely the pericardiacophrenic artery and musculophrenic artery; from the superior phrenic arteries, which arise directly from