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Abnormal Passage of Oesophagus through the Diaphragm - A Case Report

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ABSTRACT

Diaphragm is a musculo-aponeurotic sheet separating thoracic and abdominal cavities. It has few apertures in it providing passage for structures traversing between both the cavities. Out of those, oesophageal hiatus (OH) has got more surgical importance as it goes through muscular portion of diaphragm and is prone to changes in hiatal diameter due to excursions of diaphragm. This should lead to stomach herniation into thoracic cavity and acid reflux with inspiration but it is prevented by the arrangement of crural diaphragm around the OH and angle at the entry of oesophagus into stomach as studied by Collis et al. However, due to age or congenital defects, above mentioned pathologies do occur. This has led to pronounced research into normal anatomy of OH and most of the studies have found that right crus provides significant contribution to OH margins. During cadaveric dissection at our college in the department of Anatomy, we have a found OH, in a cadaver, bounded by the crura on both sides and median arcuate ligament anteriorly. Aorta and other routinely found structures are seen passing through the same hiatus posterior to the oesophagus. Precise knowledge about oesophageal hiatus is essential for better understanding of physiological and clinical phenomena.

Key words: Diaphragm openings, Oesophageal hiatus, Crura, Median arcuate ligament.

INTRODUCTION

Diaphragm is a dome shaped, musculofibrous sheet separating the thoracic cavity from the abdominal cavity. Its convex superior surface faces thoracic cavity and concave inferior surface faces abdominal cavity. The muscular component of diaphragm arises from the circumference of thoracic outlet and it has 3 components i.e. sternal, costal and lumbar. Sternal fibres arise from the posterior aspect of xiphoid process and costal fibres from the inner surface of lower six costal cartilage and ribs, interdigitating with transversus abdominis. The lumbar part arises from medial and lateral arcuate ligaments, which extend across psoas major and quadrates lumborum muscles, and also from the right and left crura. The right crus arises the anterolateral surfaces of the bodies and intervertebral discs of the upper three lumbar vertebrae. The left crus arises from the corresponding parts of the upper two lumbar vertebrae. The medial tendinous margins of the crura meet in the midline to form an often poorly defined arch, the median arcuate ligament. All these fibres insert into central tendon. Many structures pass between the abdominal and thoracic cavities through the openings in the diaphragm. However there are mainly three openings for the passage of inferior vena cava, esophagus and aorta. Caval opening, quadrilateral in shape, lies at the level of intervertebral disc between 8th and 9th thoracic vertebrae and passes through the central tendon of diaphragm. It conveys IVC, which adheres to the margins of opening, and right phrenic nerve. Aortic opening is seen at the level of 12th thoracic vertebra, conveying aorta, thoracic duct,

lymphatic trunks, azygous and hemiazygous veins. It is bounded by crura on both sides, vertebral column posteriorly and median arcuate ligament anteriorly. Anterosuperiorly and to the left of this, oesophageal opening (elliptical in shape) is present. It lies at the level of 10^{th} thoracic vertebra and transmits the oesophagus, vagal trunks and gastric nerves, oesophageal branches of the left gastric vessels and some lymphatic vessels. It is bounded by muscle fibres that originate from the medial part of the right crus and cross the midline, forming a loop approximately 2.5 cm long, around the terminal part of the oesophagus. Inner fibres of this loop are circumferentially arranged. The condensed peri-esophageal tissue forms "phernico-esophageal ligament" which is attached to esophagus and prevents upward displacement of the same. Repeated stress and loss of elastic fibres in the phernico-esophageal ligament causes widening of oesophageal hiatus (OH) and leads to the formation of sliding hernia. [1] Oesophageal hiatus is most vulnerable to visceral herniation because it faces directly into the abdominal cavity and, hence, is directly subjected to the pressure stresses between the two cavities. [2] Though it is widely accepted that muscle fibres from the diaphragmatic crura form the boundaries for oesophageal hiatus, there are many disagreements between various authors regarding contribution of crura to the boundaries of this hiatus. Thus it becomes necessary to thoroughly understand/report the variations in formation of oesophageal hiatus for a successful hernial repair.

CASE REPORT

During routine dissection session of Anatomy, as a part of undergraduate curriculum, we found a variation in the passage of oesophagus through the diaphragm of a 65 year old, male cadaver. The sternal, costal and lumbar origins of diaphragmatic fibres were normal. Oesophageal opening in the diaphragm was bounded by crura on both sides and median arcuate ligament anteriorly. Median arcuate ligament was well developed. Aorta was found to enter into the abdominal cavity through the same opening along with other structures like azygous vein and thoracic duct, posterior to the oesophagus. Vena Caval opening was in its usual location i.e. within the central tendon. No other abnormalities were found in the abdomen and other regions of the body.

DISCUSSION

Diaphragm is chiefly an inspiratory muscle along with non-ventilatory functions. As it separates the abdominal and thoracic cavities; there are several structures which will either pass through it, or between it and the body wall including blood vessels, nerves and the oesophagus. There are various apertures to do the same but three large openings are constantly found. They are aortic opening (osseo-aponeurotic), oesophageal and vena caval openings, approximately, at the level of T12, T10 and T8 vertebra respectively. Out of these apertures, oesophageal hiatus (OH) has attracted considerable attention as it is prone to more changes during diaphragmatic excursions. It may be because the opening is not completely filled by the contents to allow for expansion of oesophagus [2] and there is possibility of weakening of phernico-esophageal ligament with aging. Since middle of 20^{th} century, there has been considerable research into functional and anatomical factors causing acid reflux. Subsequently it was found that high pressure in the physiological lower oesophageal sphincter, angle of entry of esophagus into stomach and the formation of oesophageal hiatus by the crura of diaphragm were found to have key role in preventing acid reflux, hiatal hernia etc. [3,4]

In this setting, various studies were conducted to demonstrate the formation of OH anatomically and the pillars or crura were found to have an important role in the same. But there were many disagreements. Collis et al [3] found 15 different types of arrangement of crura in formation of OH. Listerud & Harkins [5] described 11 different

types of formation. A study by Loukas M et al [6] showed 6 different types of OH formation. In spite of these differences, all the studies agreed that significant contribution was made by fibres of right crus. [3, 6-8] In majority of the subjects, the right crus divides into a dorsal bundle and a ventral bundle. Dorsal bundle forms the left limb and the ventral bundle forms the right limb of OH. As they approach the OH, these limbs cross each other in a scissor-like manner and bound the hiatus. The lateral fibers of each limb insert into the central tendon while the medial fibers form the hiatal margins and decussate at the midline in front of the esophagus. [9] Such an arrangement is required to close the lumen of oesophagus, maintain the angle between oesophagus and stomach (to avoid acid reflex), and also to prevent excessive widening of OH, during inspiration. [3]

But the cadaver in our case showed the oesophagus passing through an opening which was bounded by the crura on both sides and median arcuate ligament anteriorly (Fig 1). Thus OH was not surrounded by muscles from either crura. Aorta was seen to be passing beneath the esophagus through the same opening. This finding goes in contrary to the findings of previous literature, which stresses the role of crura in closing the lumen of esophagus and preventing upward displacement of gastroesophageal junction during inspiration. Since it is a cadaveric finding, we could not elicit the person's medical history. To the best of our knowledge, none of the previous literature has showed such an arrangement of OH.

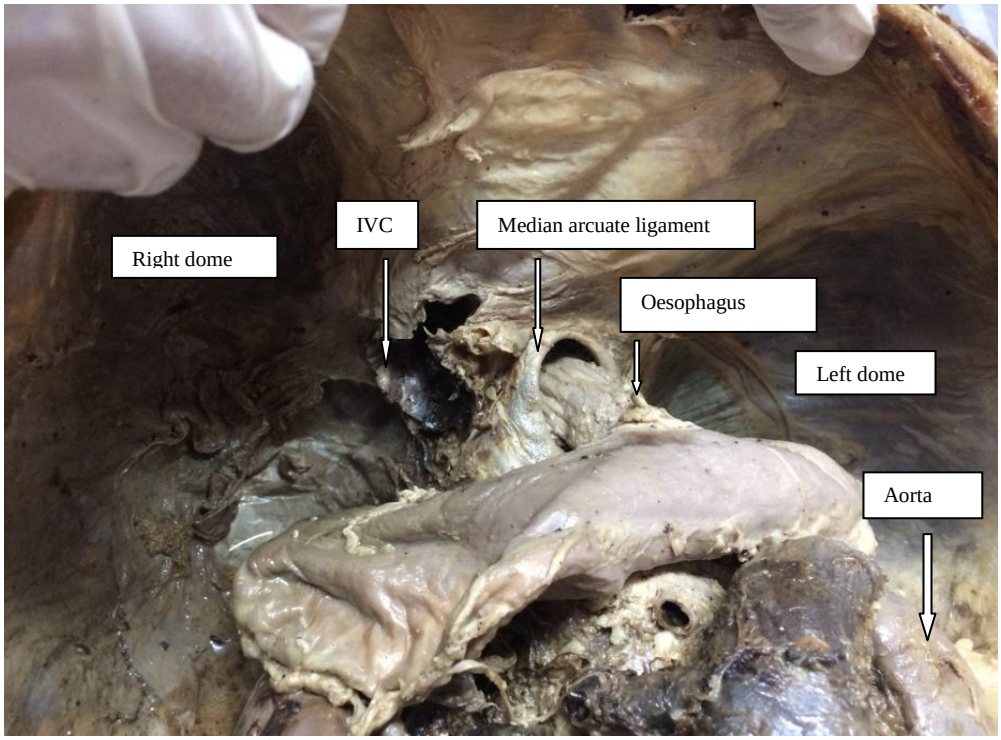

Fig 1: Passage of oesophagus in between the two crura. (IVC = Inferior Vena Cava).

Embryological basis:

The diaphragm develops from the following sources. [10]

1. The septum transversum, which forms the central tendon of the diaphragm
2. The two pleuroperitoneal membranes
3. Muscular components from somites at cervical segments three to five
4. The mesentery of the esophagus, in which the crura of the diaphragm develop.

According to textbooks, musculature of diaphragm is derived from lateral body wall and oesophageal mesenchyme in its dorsal mesentery in addition to somites of cervical region. But studies by Babiuk RP [11] et al

and Murphy M et al [12] proved that no such evidence exists and also denied that crural diaphragm is from any particular source other than myogenic cells accompanying phrenic axon outgrowth. Based on these findings, we would suggest that the current finding might be due to the absorption of dorsal mesentery of distal oesophagus, moving its exit through diaphragm more posteriorly, without having to involve formation of crura.

Conflict of interest: None declared.

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