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Case Report
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Unilateral Duplicated Right Crus of Thoraco - Abdominal Diaphragm: a Case Report

Jessy J P[1], Neerja Rani[2], Sarah S Sangma[3], Neelam Verma[4], Saroj Kaler[5], Seema Singh[5]

[1]Department of Anatomy, All India Institute of Medical Sciences, Ansari Nagar, Delhi, India
[2]Neerja Rani, Department of Anatomy, All India Institute of Medical Sciences, Ansari Nagar, India.
[3]Department of Anatomy, All India Institute of Medical Sciences, Ghorakhpur, Uttar Pradesh, India
[4]Department of Anatomy, Maulana Azad Medical College, Delhi, India
[5]Department of Anatomy, All India Institute of Medical Sciences, Ansari Nagar, Delhi, India

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ABSTRACT

Introduction: diaphragm forms the musculoaponeurotic partition between the thoracic and abdominal cavities with its attachments from the sternal, coastal, lumbar attachments along with medial and lateral arcuate ligaments. Diaphragm forms the principle muscle of inspiration. Duplication is more frequently observed on the right sided; and the lower lobe of the lung may be partially or completely contained within the accessory diaphragm and the true hemidiaphragm. The right crus of the diaphragm were found to be duplicated to medial and lateral parts. The morphometric measurements of the duplicated crus were noted along with the left crus. Knowledge of variations in the diaphragmatic crural anatomy may be important for the diagnosis of disease processes and the surgical resection of tumors. This variation in the diaphragmatic crura is also important in understanding the gastrointestinal physiology and pathological conditions.

Keywords: Diaphragm; Crura; Rretrocrural space; Oesophageal hiatus; Duplication.

Introduction

Thoracoabdominal diaphragm develops from septum transversum, pleuroperitoneal membranes, dorsal mesentry and muscular ingrowths from lateral body walls between 3rd to 8th weeks of intrauterine life[1]. The right crus and left crus attach to the lumbar vertebrae and develops from muscle fibres which grow into oesophageal mesentry thus enclosing the oesophageal hiatus[2].

Diaphragm presents sternal, coastal, lumbar attachments along with medial and lateral arcuate ligaments[3]. The right crus arise from the upper three lumbar vertebrae and the corresponding intervertebral discs, is longer and stronger. The left crus arise from the bodies of upper two lumbar vertebrae and the corresponding intervertebral discs, is shorter[4].

Few studies suggest lower attachment of right crus to the fourth lumbar vertebrae and the left crus to the third lumbar vertebrae[5]. The formation of oesophageal hiatus gets its contribution from both right and left crus[6]. The crural fibres which take part in the formation of hiatus act on the gastroesophageal junction by forming gastroesophageal reflux barrier and prevents gastroesophageal reflux such as swallowing, vomiting[4].

The costal and sternal fibres of diaphragm have a major respiratory role and the crural diaphragm a minor respiratory role[4]. The crura are related to various important structures, thus variations of diaphragm are necessary to treat the thoracoabdominal abnormalities effectively. Thus, a good knowledge of variations in the diaphragmatic crura becomes critical in understanding gastrointestinal physiology.

Embryologically duplication of the diaphragmatic crura is thought to result from improper timing in the interaction of the lung buds and septum transversum[2]. Duplication can also be associated with cardiovascular malformations and ipsilateral pulmonary maldevelopment. It has been observed and reported in few literature that the duplicated accessory diaphragm extends obliquely upward and backward to attach to third to seventh ribs posteriorly. Duplication is more frequently observed on the right sided; and during the cross-sectional imaging, the lower lobe of the lung may be partially or completely contained within the accessory diaphragm and the true hemidiaphragm[3].

Retrocrural space is a small triangular region situated in the posterior mediastinum, anteriorly bounded by two diaphragmatic crura[4]. This space is related to pathological conditions and thus the anatomical variation in crura of diaphragm are important clinically for various diagnostic procedures involving this compartment. In the present case we thus present unilateral duplicated right crus of diaphragm with its morphometry.

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Case Report

The present case was observed during routine dissection for the MBBS undergraduates in an adult male cadaver of 65 years at All India Institute of Medical Sciences, New Delhi, India.

The right crus of the diaphragm was seen to be duplicated as separate bellies having medial and lateral parts. The distal attachments were seen to be tendinous to the third lumbar vertebrae. The length of the muscular part varied, with the medial part being 8.5cm and the lateral part being 10.5cm (Fig 1). The lateral right crus merged with the medial part at the second lumbar vertebrae. The tendon of the lateral crus was shorter than the tendon of medial crus. The tendon of the lateral crus measured 6.00cm and that of medial crus measured 8.00cm. The breadth of the medial part of right crus measured 3.5cm in upper and 1.5cm in lower part. The breadth of the lateral part of the right crus measured 3.5cm in upper and 1.00cm in lower part. The medial part of the right crus contributed for the formation of oesophageal hiatus (Fig 2). The left crus were found to be normal with length measuring 9.00cm and breadth measuring 3.00cm.

The splanchnic vessels were seen to pass between the duplicated right crus of the diaphragm.

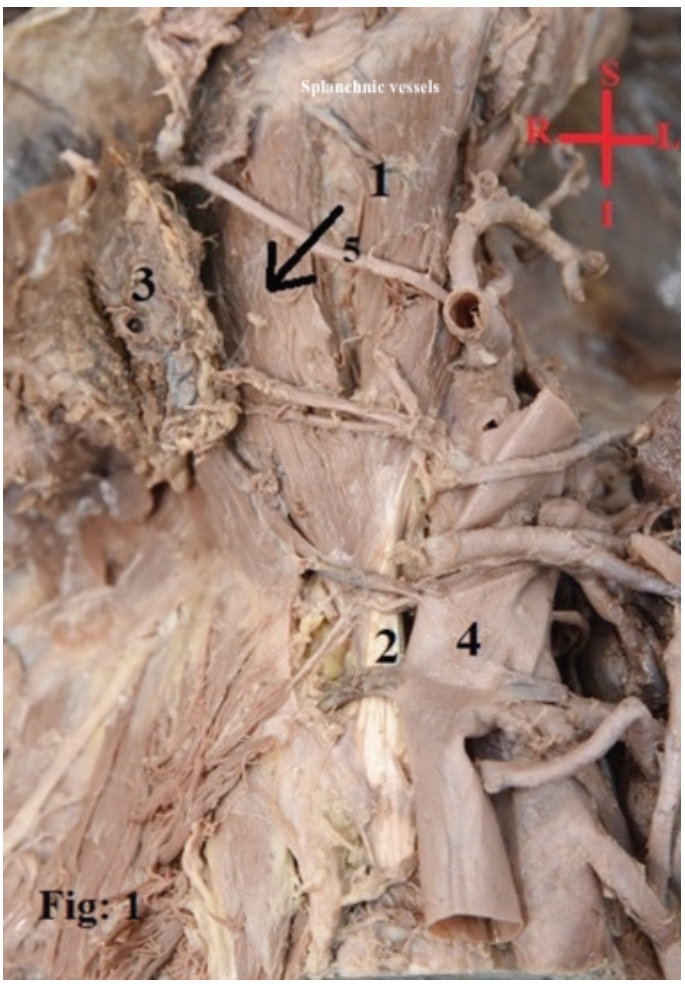

Figure 1. Photograph of posterior abdominal wall showing: 1. Right crus (Muscular part - 9cm; Tendinous part 8cm); 2. Tendon of both right and left crus; 3. Suprarenal gland; 4. Inferior venacava; 5. Right inferior phrenic artery.
• Note: Arrow showing accessory right crus (Muscular part- 10.5cm, Tendinous part- 8cm).
• Accessory crus merged with the main right crus at second lumbar vertebrae.

Figure 2. Photograph of posterior abdominal wall showing: 1. Left crus (Musclular part- 9cm); 2. Tendon of left crus (measuring- 2cm, attached to second lumbar vertebrae); 3 & 4. Right crus forming oesophageal hiatus; 5. Oesophagus (cut edge).
• Note: The right crus contributing for the formation of oesophageal hiatus.

Discussion

The diaphragm forms the musculoaponeurotic partition between the thoracic and abdominal cavities. The muscle takes attachment from three parts, sternal, costal and lumbar. The lumbar part arises from the lumbar vertebrae as crura and also from the arcuate ligaments. The vertebral attachment of crura are tendinous and merge with the anterior longitudinal ligament. The right crus arises from the anterolateral surface of the first three lumbar vertebral bodies and intervertebral discs (IVDs)[4]. The left crus arises from the upper two lumbar vertebrae and the intervening IVD. The medial margins of right and left crura meet in the midline forming the median arcuate ligament and forms the aortic hiatus[3].

The oesophageal hiatus, an opening in the muscular part of the diaphragm at the level of T10 vertebral

body, gets contribution from the muscle fibres of both right and left crura[4]. Literature suggests the role of crural diaphragm in preventing the development of gastroesophageal reflux. Any surgical or pathological process that affects the structural integrity of the wall of the oesophageal hiatus will interfere with the mechanics of the gastroesophageal junction[5]. A good knowledge in the structural variations of the diaphragmatic crura becomes critical in understanding of gastrointestinal physiology. Literature suggest various morphological patterns of circumferential muscle fibres forming the oesophageal hiatus and classified them into six groups. The most common type of oesophageal hiatus the Type I (45%) was formed by the muscular contributions arising only from the right crus. Type II (20%) formed by the equal muscular contributions from the right and left crura. Type III (15%) formed by the right and left muscular contributions arose from the right crus with an additional band from the left crus. In, Type IV (10%) the right and left muscular contributions arose from the right crus along with two additional (anterior and posterior) bands coming from the left crus. In Type V (5%), the hiatus received contributions from the left crus only. In Type VI (5%), the right and left muscular contributions originated from the left crus with two additional bands, one from the right crus and one from the left crus[4]. Previous studies conducted on morphological patterns observed that type was predominating forming the hiatus. In the present study also the muscular fibres forming the oesophageal hiatus received contribution from the medial right crus only, similar to Type 1.

The duplication of right crus of the diaphragm has been reported in the previous literature, however information about the frequency of its occurrence is scanty. In the present case duplication of right crus was observed with medial and lateral parts and the lateral right crus merged with the medial part at the second lumbar vertebrae.

The diaphragmatic crura are related to various structures. Therefore, it is necessary to known all the possible anatomical variations of the diaphragm to treat the thoracoabdominal deformities effectively. The aortic opening is bounded by both the diaphragmatic crura, which may get compressed against the vertebral bodies causing compression syndrome due to decreased arterial supply[7]. There are chances of the crural attachments to exert pressure on the lumbar arteries. The compression of right second lumbar artery by the diaphragmatic crus causes transient and recurrent paraplegia[8].

Malignancies of the diaphragmatic crura occur by local or hematogenous spread of tumour. Various muscular tumors like leiomyosarcomas, rhabdomyosarcomas, lipomas and desmoids are the primary neoplasms reported to occur in the diaphragmatic crura[3]. The intrathoracic malignancies such as pleural mesothelioma and metastatic lung or oesophageal malignancies may spread and cause subsequent invasion of the diaphragmatic crura[3]. The knowledge of these variations of the diaphragmatic crura is helpful during the diagnosis and treatment of the malignancies of the crura and also as an indicator for diaphragmatic injury in the setting of various trauma.

Retrocrural space is a small triangular region situated in the posterior mediastinum, anteriorly bounded by two diaphragmatic crura. The contents of this space are sometimes subjected to various pathologic processes like lipoma, lymphangioma, vascular abnormalities like aortic aneurysm, hematoma, azygos and hemiazygos and abscesses[5]. Knowledge of variations in the diaphragmatic crural anatomy may be important for the diagnosis of disease processes and the surgical resection of tumors in this retrocrural space[4]. The medial branches of the lower thoracic sympathetic ganglia: the greater and lesser splanchnic nerves, enter the abdomen by piercing the diaphragmatic crura. In the present case the duplicated right crus gave passage to the splanchnic vessels between the two right crura which was compared to the finding done by Rao *et al*[2]. The splanchnic vessels and nerves in this space, would undergo compression or entrapment against the posterior body wall during respiration, leading to abnormal oesophageal, gastric and intestinal functions causing gastrointestinal reflux disease[5]. This variation of splanchnic nerves in the retro- crural space is important for performing image guided techniques for percutaneous blockade of the celiac plexus. Few literature also suggest compression of renal arteries by the diaphragmatic crus causing reno vascular hypertension[9]. Literature also suggest that the arterial hypertension in young individuals can be because of renal artery stenosis due to compression of renal artery by diaphragmatic crus[9].

Conclusion

Retrocrural space is a small triangular region situated in the posterior mediastinum, anteriorly bounded by two diaphragmatic crura. Knowledge of variations in the diaphragmatic crural anatomy may be important for the diagnosis of disease processes and the surgical resection of tumors in this retrocrural space. Also variation in diaphragmatic crura is important in understanding the gastrointestinal physiology and pathological conditions (tumours, vascular abnormalities, abscesses) which facilitate diagnosis of disease processes within this often overlooked anatomical structure.

Ethics Statement

The authors state that every effort was made to follow all local and international ethical guidelines and laws that pertain to the use of human cadaveric donors in anatomical research[10].

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Corresponding author
Neerja Rani
E-mail: neerja.sirohi@gmail.com