CASE REPORT

A case of morphological variations in the diaphragmatic crura and a congenital venous connection between the inferior vena cava and hemiazygos vein

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Abstract

The crural parts of the diaphragm play a key role in gastro-oesophageal functions. The duplication of the crura may be the result of improper timing in the interaction between the lung buds and dorsal mesentery. In abdominal imaging, the Inferior Vena Cava (IVC) is a crucial structure. It is associated with several congenital and pathologic processes. This study report a rare diaphragmatic crural pattern, the formation of the oesophageal hiatus, the abnormal position of the right coeliac ganglion, the unusual course of the right lumbar sympathetic trunk, and the congenital venous connection between the IVC and hemiazygos vein. Understanding these details can aid in radiological image interpretation and retroperitoneal surgical treatments.

Keywords: Coeliac Ganglion, Congenital Venous Connection, Diaphragmatic Crura, Lumbar Sympathetic Trunk, Oesophageal Hiatus

Introduction

The diaphragm develops from four components: septum transversum, pleuroperitoneal membranes, muscular parts from somites, and the oesophagus's dorsal mesentery. The right and left crura are attached to lumbar vertebrae, forming the hiatus and median arcuate ligament arch over the abdominal aorta. The right crus originate from the upper three lumbar vertebral bodies and discs, while the left crus originate from the first and second lumbar vertebrae and disc [1]. The oesophageal opening is surrounded by the left crus and the medial part of the right crus at the tenth thoracic vertebra. The innermost fibres are arranged circumferentially, while the outermost fibres run craniocaudally. Thoracic splanchnic nerves reach the abdomen via the diaphragmatic crura or medial arcuate ligaments along the sympathetic trunk [1].

The Inferior Vena Cava (IVC) is formed by anastomoses and regression of embryonic veins, including the paired posterior cardinal, subcardinal, supracardinal, and vitelline veins. The hemiazygos vein originates from the upper left supracardinal vein and is formed by the confluence of the left ascending lumbar and left subcostal veins. The hemiazygos vein connects with the left renal vein via the lumbar azygos vein, entering the thorax via the aortic hiatus or diaphragmatic crura [1]. This study is to determine the unusual origin of diaphragmatic crura, the formation of the oesophageal orifice, and the structures that pass posterior to the right and left medial arcuate ligaments.

Case report

A unique anatomical pattern in an adult male's posterior abdominal wall was observed during a routine dissection in the Anatomy Department of King Khalid University, Abha, Saudi Arabia. The study was approved by the Research Ethics Committee (ECM#2024-1903).

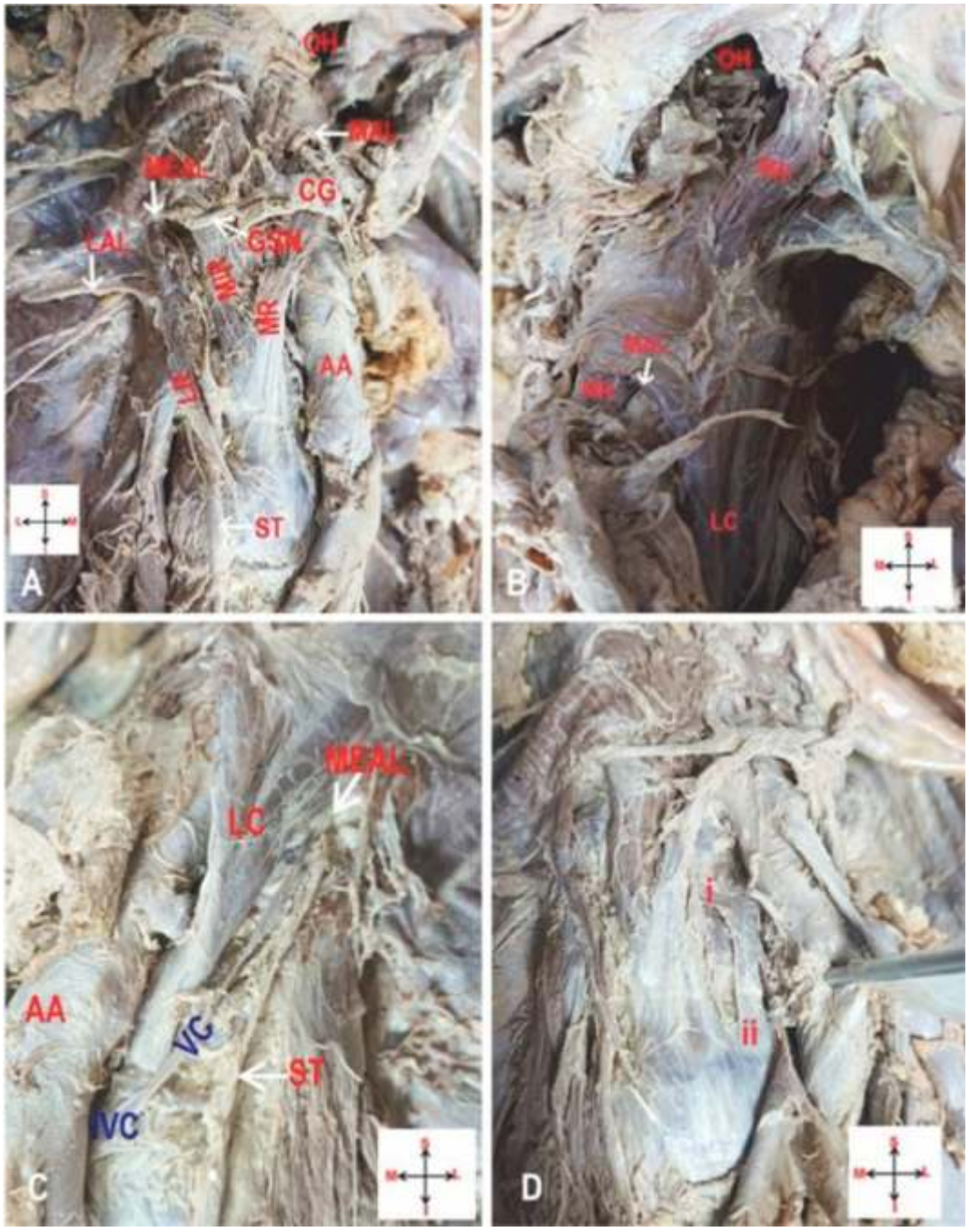

Figure 1A:Show the medial bundle (MR), middle bundle (MIR), and lateral bundle (LR) of the right crus. AA: Abdominal Aorta, CG: Coeliac Ganglion, GSN: Greater Splanchnic Nerve, OH: Oesophageal Hiatus, ST: Sympathetic Trunk.Median, medial, and lateral arcuate ligaments (MAL, MEAL, and LAL). Figure 1B and C: LC: Left Crus. C- IVC: Inferior Vena Cava, VC: Venous Connection. Figure 1D: i and ii are the origins of the left crus. S: Superior; I: Inferior; M: Medial; L: Lateral.

All anatomical variations were meticulously dissected and documented through photography.

The right crus consisted of three bundles: medial, middle, and lateral, all originating from the third lumbar vertebral body. The medial bundle ascended posteriorly to the median arcuate ligament and connected to the left dome of the diaphragm's abdominal surface. The middle bundle connected to the left crus, and the lateral bundle attached laterally to the lateral arcuate ligament. The right lumbar sympathetic trunk and greater splanchnic nerve passed posteriorly to the medial arcuate ligament. The greater splanchnic nerve joined with the coeliac ganglion on the medial bundle of the right crus and abdominal aorta. The right lumbar sympathetic trunk descended through the intercrural space and passed behind the lateral bundle of the right crus at the third lumbar vertebral body level (Figure 1).

The left crus originated from the first intervertebral disc (IVD) and the third lumbar vertebral body (Figure 1). The oesophageal hiatus was not surrounded by the diaphragmatic crura but had an ascending medial bundle of the right crus on the left side at the tenth thoracic vertebral level (Figure 1). The third lumbar vertebral body's lower border had a congenital venous connection between the IVC and the hemiazygos vein. It crossed the left third lumbar artery, ascending posteriorly to the medial arcuate ligament, and joining with the hemiazygos vein (Figure 2).

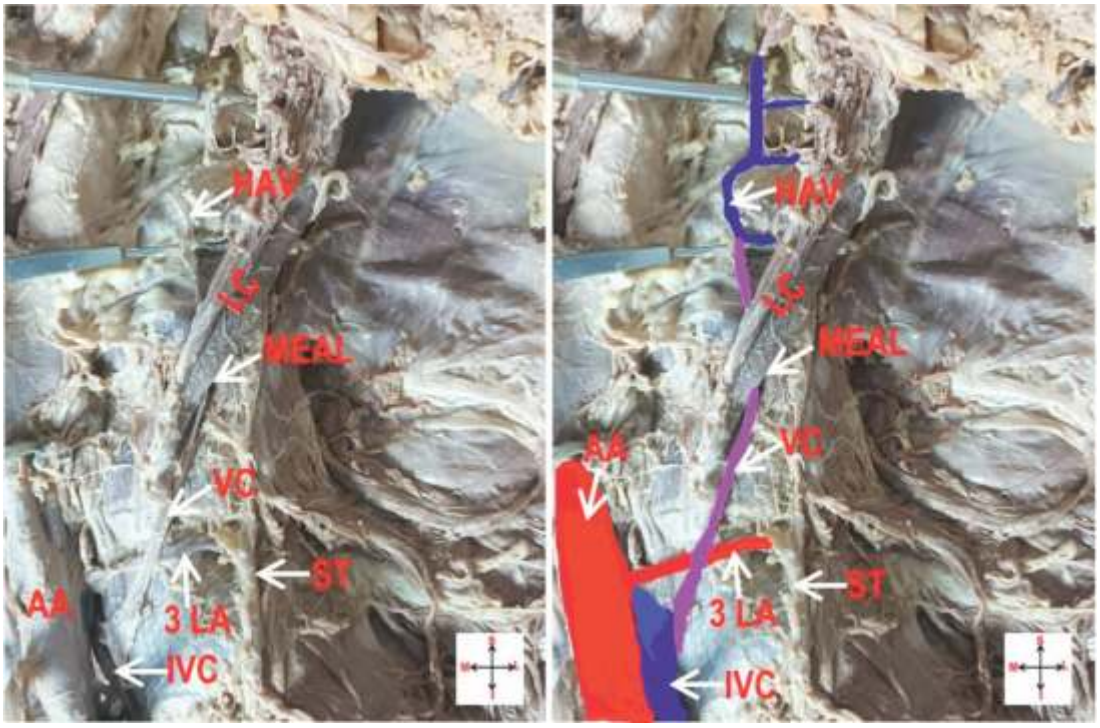

Figure 2: Show a congenital Venous Connection (VC) between the Inferior Vena Cava (IVC) and the Hemiazygos Vein (HAV). 3 LA: third Lumbar Artery, Abdominal Aorta (AA), LC: Left Crus, MEAL: Medial Arcuate Ligament, ST: Sympathetic Trunk. S: Superior; I: Inferior; M: Medial; L: Lateral.

Discussion

The diaphragm, which originates from the inner transversus layer of body wall muscles, plays a crucial role in respiratory and gastro-oesophageal functions [2]. The crura develops from the oesophagus' dorsal mesentery and may undergo duplication due to improper timing in the interaction of the lung buds and septum transversum [3].

The right and left crura have different origins, and the right crus is unilaterally duplicated. In duplicated right crus, the lateral right crus originate from the IVD between the third and fourth lumbar vertebrae, while the medial right crus originate from the anterolateral surface of the upper three lumbar vertebrae and intervening discs [4]. The right arm originates from L1 to L4 in 45%, from L2 to L4 in 32%, and from L2 to L3 in 23% of the specimens [2]. In 98% of cases of another study reported [5], medial, middle, and lateral bundles of the right crus and these three bundles were observed in the present study. All three bundles of the right crus originated from the third lumbar vertebral body. Themedial bundle ascended posteriorly to the median arcuate ligament and attached to the left dome of the diaphragm. The middle bundle medially formed the median arcuate ligament and laterally attached to the medial arcuate ligament, while the lateral bundle medially and laterally joined the medial and lateral arcuate ligaments.

The sympathetic trunk enters the abdomen between the lateral and intermediate parts of the right crus [6]. The same course was observed in this current study, and then it descended through the intercrural space. The right lumbar sympathetic trunk passed behind the lateral bundle of the right crus at the third lumbar vertebral body level, but no data is available on this type of course. Also, the right greater splanchnic nerve passed to the medial arcuate ligament, which connected with the coeliac ganglion on the medial bundle of the right crus and abdominal aorta. The right coeliac ganglion typically occurs posterior to the IVC [1].

In this study, the left crus originated from the first IVD and the third lumbar vertebral body. It originated from L3, L2 and L3; L2 and L1; and L3 as reported in other studies [2, 7]. The oesophageal hiatus was not surrounded by a crura but rather by the ascending medial bundle of the right crus on the left side at the tenth thoracic vertebral level. In 16% of cases of another study [5] reported, the oesophageal hiatus was not directly contributed by the crura. The oesophageal hiatus has been studied for different types based on the crus fibres contributing to its formation [2, 5]. The oesophagogastric junction is supported by the lower oesophageal sphincter and the crural diaphragm, preventing gastro-oesophageal reflux through diaphragmatic crural support [8].

A congenital venous connection between the IVC and hemiazygos vein was observed in this study, and a similar venous connection was reported in another study [9]. It was crossing the left third lumbar artery and ascending posteriorly to the medial arcuate ligament along the medial side of the sympathetic trunk and joining with the hemiazygos vein. Congenital IVC interruption with azygos/hemiazygos continuation can be attributed to failure to obliterate intermediate supracardinal veins or lack of hepatosubcardinal anastomosis establishment [10].

Conclusion

Understanding the anatomy of the lumbar sympathetic trunk, oesophageal hiatus, coeliac ganglion, diaphragmatic crura, and venous connection between inferior vena cava and hemiazygos vein might enhance surgical results and avoid incorrect diagnoses of gastro-oesophageal reflux disease.

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