Case report

Accessory crus of diaphragm – a *human* morphological case report

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Abstract

During the routine anatomical cadaveric dissections performed for medical students, it was observed that, an unusual morphology of the right crus of diaphragm was present. There were two crura on the right side of diaphragm and the left side was normal. We believe that this case is of worth reporting, since it will be enlightening to the clinicians and researchers. The embryological basis and clinical implications are discussed.

Keywords: accessory, crus, crura, diaphragm.

1 Introduction

Diaphragm is the muscle of respiration which separates the thorax from abdominal cavity. It consists of a central tendon, a right and left domes and attachments to the vertebra, ribs and sternum. The vertebral attachments are known as the crura which arise from upper lumbar vertebral bodies, originating as low as the third lumbar body. The right crus arise from L1 to L3 and the left crus extends from L1 to L2 (PANICEK, BENSON, GOTTLIEB et al., 1988; SILVERMAN, COOPER and ZEMAN, 1992). From these origins, the crura ascend upwards to get inserted onto the central tendon. At their origin the crura are tendinous in structure and blend with the anterior longitudinal ligament of vertebral column (AHMAD, KAUKAB, IKRAM et al., 2011). The right crus, sends a few medial fibres which encircle the oesophagus and sometimes also has a fleshy fasciculus arising from the left crus which runs towards the venacaval opening. Moore and Persaud (2003) opined that most of the diaphragm related abnormalities might be caused due to faulty development at the various stages of development. In this report, we present a rare variation in which double right crura were observed in a south Indian male cadaver. The embryological and clinical highlights are emphasized.

2 Case Report

During the dissection of a male cadaver of aged about 68 years, performed for the teaching of medical students, an unusual presentation of the vertebral origin of diaphragm was observed which showed the accessory right crus (Figure 1). However the left crus was presented normally. The anomalous accessory right crus was having ribbon shaped morphology and arose from the right psoas major muscle. Later it got blended with the right crus at its proximal attachment (Figure 1). The accessory muscular strip was 1.8 cms in thickness and 7.2 cms in length. The normal and accessory right crura were separated by an interval of 0.7 cms throughout its length except towards its distal attachment. The other parts of diaphragm exhibited the normal morphology.

3 Discussion

The term crura, the plural of crus are derived from the Latin word cruralis, meaning "leg" (RESTREPO, ERASO, OCAZIONEZ et al., 2008). It is well known that the crural and costal parts of diaphragm are not only distinct anatomically and functionally, but also have separate origins and nerve supply. During human development of costal diaphragm, myoblasts originating in the body wall probably derived from 3rd, 4th and 5th cervical segments, invade the pleuroperitoneal membranes (GREER, ALLAN, MARTIN-CARABALLO et al., 1999). The diaphragm forms from the 4th to 12th week of intrauterine life. By the 4th week, the coelom or body cavity appears as a horseshoe-shaped cavity in the cardiogenic and lateral mesoderm, this cavity will later give origin to the thoracic and peritoneal cavities. By the 6th week, the pleuropericardial membranes extend medially and their free edges fuse with mesentery of esophagus and with the septum transversum, separating the pleural cavities from peritoneal cavity. Further growth of myoblasts will ensure pleuroperitoneal openings, forming the posterolateral elements of the diaphragm. The dorsal mesentery of the esophagus constitutes the median portion of the diaphragm. The diaphragmatic crura develop from myoblasts that grow into the dorsal mesentery of the esophagus (MOORE and PERSAUD, 2003; SADLER, 2006).

The knowledge about variations of diaphragmatic crura is necessary due to the fact that it is related to numerous structures around it. It might help in understanding the role played by it in various physiological processes and in treatment of gastroesophageal reflux disease, hiatal hernia and Dunbar's syndrome (AHMAD, KAUKAB, IKRAM et al., 2011; LOUKAS, WARTMANN, TUBBS et al., 2008). Right and left crura of diaphragm form lateral limit to the aortic opening of diaphragm through which the thoracic aorta passes downwards to continue as abdominal aorta. If

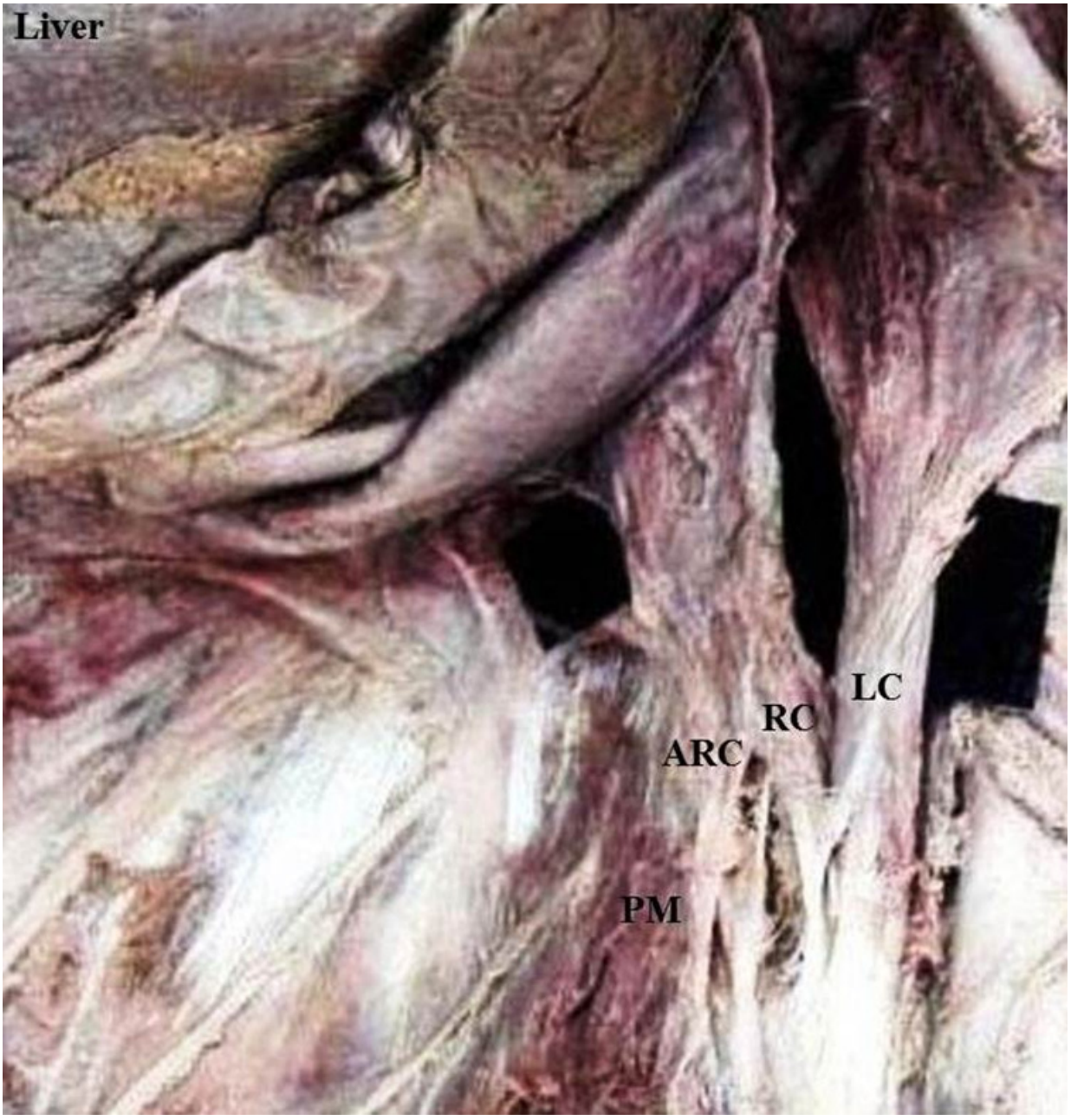

Figure 1. Photograph of the abdominal cavity of male cadaver showing the accessory right crus (ARC) of the diaphragm (RC-right crus; LC-left crus; PM-psoas major muscle).

the relation between two crura and the pre-vertebral muscles is altered, it could lead to abnormal conditions involving the aorta and its branches, most commonly the celiac trunk compression syndrome. Due to these situations, the celiac trunk compression syndrome was denominated as celiac-phrenic disorder (PETRELLA and PRATES, 2006).

Partial duplication of the diaphragm may involve the crura. It is thought to result from improper timing in the interaction of the lung buds and septum transversum (RESTREPO, ERASO, OCAZIONEZ et al., 2008). There is mounting evidence which suggests that the diaphragm should be more correctly be characterized as two separate muscles, the crural diaphragm and costal diaphragm (DE TROYER, SAMPSON, SIGRIST et al., 1981). De Troyer, Sampson, Sigrist et al. (1982) showed that while costal diaphragm expands the lower rib cage, crural diaphragm does not change the dimensions of rib cage appreciably. The crural diaphragm has a minor respiratory role, but is greatly involved in gastroesophageal functions like swallowing, vomiting and contributing to gastroesophageal reflux barrier.

The diaphragmatic crus are oriented anteriorly, caudal to crania and could exert very little compression on the first two lumbar arteries. Second right lumbar artery is the most commonly affected as it is longer than the second left lumbar artery and is applied against the convexity of vertebral body by the right diaphragmatic crus, which is thicker than the left crus (ROUVIÈRE, 1967). Batt, Rogopoulos,

Benchimol et al. (2008) reported 3 cases of transient and recurrent paraplegia due to compression of the second right lumbar artery by the diaphragmatic crus. It was suggested that the idea of correlation between the diaphragmatic crura and lumbar arteries is very helpful in the differential diagnosis (BATT, ROGOPOULOS, BENCHIMOL et al., 2008). Although cases of double right crus of diaphragm unilaterally have not been reported, there have been cases where a cleft within the crura mimics the presence of two separate crura. Martin (1971) reported a case in which the right renal artery was found to pass through a cleft in the right crus of diaphragm.

Sometimes the crura are hypertrophied and mimic the presence of an abnormal para-spinal mass when a x-ray is taken. Such cases could probably be seen in people who frequently exert the diaphragm extensively like in trained athletes, opera singers etc (WOODRING and BOGNAR, 1998). The thorough knowledge about development of diaphragm from its various sources is very crucial for differential diagonosis of thoraco-abdominal deformities. This could also help the medical and surgical practitioners in choosing the right approach towards the treatment strategy. Embryologically it has been established that right crus of the diaphragm develops from dorsal mesoesophagus and the ligaments of stomach develop from dorsal mesogastrium. However defective right crus of diaphragm are not reported thus far as a separate entity (SIVAKUMAR, 2008). Even the chart for all the diaphragmatic defects (GRAY and SKANDALKIS, 1972) does not mention about the defects of crus of diaphragm. Sivakumar (2008) recommended a closer look for the defect of crus of diaphragm while operating a case of gastric volvulus.

The gastrointestinal physiologists are increasingly becoming aware of value of crural diaphragm in helping to stop gastric contents from refluxing into the esophagus (AHMAD, KAUKAB, IKRAM et al., 2011). An understanding of the anatomical variants of diaphragmatic crura facilitates the diagnosis of disease processes within the retrocrural space (RESTREPO, ERASO, OCAZIONEZ et al., 2008). Due to all these implications, we believe that this case is of worth reporting, since it will be enlightening to the clinicians, physiologists and researchers.

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