Original Article

Variations in the Anatomy of Diaphrahgmatic Crura

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ABSTRACT

Objective: The aim of this study was to note down the variations in the attachment of diaphragmatic crura in respect to their role in gastro esophageal reflux disease, cruraltumours and thickening of crura in chest trauma.
Study Design: Descriptive study.
Place and Duration of Study: This study was conducted at the Anatomy department of Khyber Medical College Peshawar and Khyber Girls Medical College Peshawar from 2008 to 2016.
Material and Methods: 32 human cadavers were dissected irrespective of age and sex. After the removal of abdominal viscera attachment of right and left diaphragmatic crura noted. Data was analyzed by SPSS version 10.
Result: On the right side crura was attached to the bodies of L1 toL3 vertebra in 78.13% and on the left side from L1 to L2 in 75%.However in 18.75 % the lower most attachment extended to L4 vertebra on the right side and L3 in 25 % on the left side .Crurain 21.87% of cases were on the right side and 18.75%of cases on the left side merge with anterior longitudinal ligament.
Conclusion: There is a marked anatomical variations in the attachment of diaphragmatic crura. Recognition of the variant will be helpful in diagnosis and treatment of hiatal hernia, cruraltumour and crural injury.
Key Words: Diaphragmatic crura, Gastroesophagealreflux, hiatal hernia, cruraltumour, crural injury

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INTRODUCTION

The diaphragm is a primary muscle of respiration. It is dome shaped musculoaponeurotic sheet that separates the thoracic cavity from the abdominal cavity. The muscular part of the diaphragm has 3 parts sternal, costal and lumbar, based on the region of their attachment. The lumbar part arises from the arcuate ligament and from lumbar vertebrae by means of vertical columns known as crura. The crura of diaphragm arises from the anterolateral surfaces of bodies and intervertebral discs of lumbar vertebrae. They are musculotendinous bands that merge with the anterior longitudinal ligament of vertebral column. The right crura is stronger, broader and longer than the left, originating from the bodies and intervertebral disc of the first three lumbar vertebrae while the left crura from the first two lumbar vertebrae .The tendanious medial margin of the crura pass medially and anteriorly to meet in the mid line to form arch in front of the aorta called median arcuate ligament[1].

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The area behind this a is known to be aortic hiatus. The fibers originating from the xiphoid process, from the medial and lateral arcuate ligament especially from the ribs and their cartilages converges to be inserted into central tendon[2]. D Troyer et al notified in their study that while the costal diaphragm expands the lower rib cage, the crural diaphragm negligibly changes the dimension of the rib cage[3]. It seems that the crural diaphragm has a significant role in maintaining gastroesophageal reflux barrier and minor role in respiration.

The antireflux mechanism is maintained by the two sphincters at the esophagogastric junction, smooth muscle (lower esophageal end) and a skeletal muscle (crural diaphragm).The amount of contribution of the crural diaphragm compared to the lower esophageal sphincter as a antire flux barriar is difficult to determine because they are superimposed on each other[4]. The information regarding the sphincericaction of respiratory diaphragm and its relation to esophagogastric junction in previous studies have shown that the most of the physiologists were aware of the value of crural diaphragm in preventing the reflux of the gastric content into esophagus from stomach. Gastroesophageal refluxoccurs when antire flux mechanism is ineffective, allowing the acidic gastric content to esophagus[5,6]. In swallowing during inspiration the crural diaphragm briefly ceases to contract while the rest of diaphragm is contracting and allowing the bolus to pass across the diaphragm. This dramatic divergence of the activity of crural and costal diaphragm is seen during swallowing and esophageal

distention[7]. The exact mechanism that lead to the reflux inhibition of the crural diaphragm during esophageal distension is somewhat unclear[8,9] Mital et al observed in their study that the difference in the pressure gradient in esophagus (negative) and stomach (positive) during inspiration favours reflux but simultaneous contraction of the crura reinforce the esophagogastric junction. He also observed that after cruralmyotomy, the lower esophageal sphincter cannot compensate for the loss of crural muscle. During their study they came to the conclusion that some of the patients suffering from gastroesophageal disease have impaired crural function. He further stated that the incidences need to be studied further[10].

Allen and Greer demonstrated that crural and costal part of diaphragm is not only different anatomically and functionally but also developmentally. During the intrauterine life costal diaphragm develop from the myoblast that probably derived from the 3rd,4th and 5th cervical somites that invade the pleuroperitonium[11] .However in contrast to costal diaphragm, crura develop from myoblasts that grow into the dorsal mesentry[1].The motor nerve supply to the diaphragm is via phrenic nerve through separate branches to the crural and costal region[12,13] .Esophageal hiatus is an opening at the level of T12 vertebral body in the muscular part of the diaphragm, formed by the right crus of diaphragm and is the only opening of diaphragm that is susceptible to visceral herniation i.e. hiatal hernia[14].

MATERIALS AND METHODS

This descriptive study was conducted on human cadavers irrespective of age and sex during regular dissection classes to medical students in the department of anatomy Khyber medical college Peshawar and Khyber Girls Medical College Peshawar from 2008 to 2016.After removal of the abdominal viscera, the attachment of right and left crura of diaphragm was noted. The data was statistically analyzed by using SPSS version 10.

RESULTS

A total of 32 human cadavers were dissected and the attachment of diaphragmatic crura were identified on the lumbar vertebrae (Figure 1). Out of them in 25(78.13%) specimens the diaphragmatic attachment is observed to the bodies of L1 to L3 vertebra on right side and L1 to L2 vertebral bodies on the left side in 23(71.87%) specimens. However in 6(18.75%) specimens attachment found to be from L1 to L4 vertebral bodies on the right side and in 7(21.87%) specimens from L1 to L3 vertebral bodies on the left side.(Table 1).The lower most attachment extended up toL4 vertebra on the right side in 6(18.75%) specimens and on the left side upto L3 vertebra in 7(21.88%) specimens((Table 2). Crura did not merge with the anterior longitudinal ligament on the right side in 25(78.13%) specimens and on the left side in 26(81.25%) specimens (Table3).

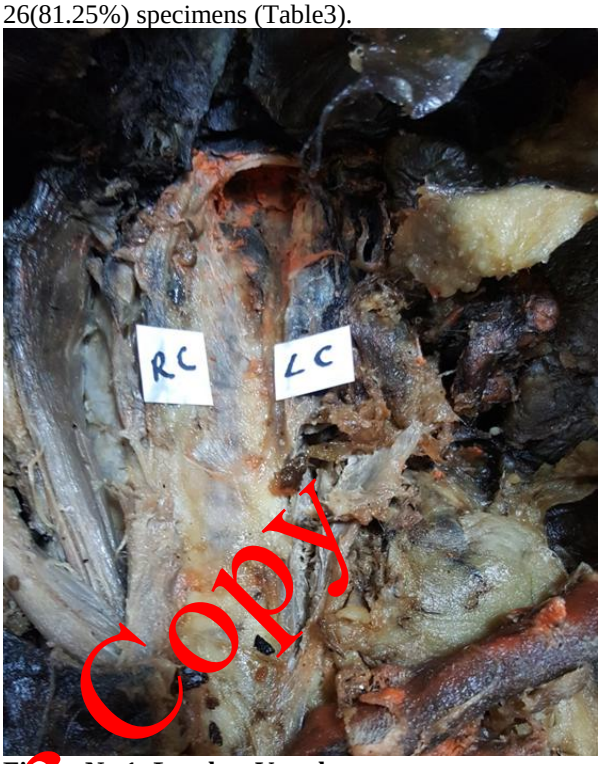

Figure No.1: Lumbar Vertebrae

Table No.1: Crural attachment to vertebral bodies

	Crura of Diaphragm	Frequency	Percent (%)
Right Crura	T12-L3	1	3.12%
	L1-L3	25	78.13%
	L1-L4	6	18.75%
Total		32	100%
	T12-L2	2	6.26%
Left Crus	L1-L2	23	71.87%
	L1-L3	7	21.87%
Total		32	100%

Table No. 2: Lower most level of cruralextension to vertebral bodies

	Crura of Diaphragm	Frequency	Percent (%)
Right Crura	L3	26	81.25%
	L4	6	18.75%
	Total	32	100%
Left Crura	L2	25	78.12%
	L3	7	21.88%
	Total	32	100%

Table No. 3: Crural attachment to anterior longitudinal ligament

	Cruraof Diaphragm	Frequency	Percent (%)
Right Crura	Present	7	21,87%
	Absent	25	78.13%
	Total	32	100%
Left Crura	Present	6	18.75%
	Absent	26	81.25%
	Total	32	100%

DISCUSSION

The term crurais derived from the Latin word crurelis meaning leg[15].The primary muscular tumour of the diaphragmatic crura namely desmoidtumour, lipoma, leiomyosarcoma and rhabdomyosarcoma have been reported. Some of the intrathoracic malignancies such as metastatic or lung malignancies may invade the diaphragmatic crura. The knowledge regarding variations of the diaphragmatic crura is helpful in diagnosis and treatment of the crural tumour[16,17]. Where the thickening of the diaphragmatic crura in trauma is an indicator of the injury[18]. Majority of the studies performed earlier reported that the attachment of diaphragmatic crura on the bodies and intervertebral discs on the right side usually extend from L1 to L3 and on the left side from L1 to L2 vertebra[5]. However one study differ in that where in maximum cases the attachment of crus of diaphragm can extend to lower border of L4 vertebra on the right side and L3 vertebra on the left side[19] .In the present study majority of the specimens the diaphragmatic crural attachment on the right side was extended from L1 to L3 vertebra in 78.13%, from T12 to L2 vertebra in 3.12% and from L1 to L4 vertebra in 18.75%. On the left side diaphragmatic crural attachment extended from T12 to L2 in 6.26 %, from L1 to L2 in 71.87 % and from L1-L3 in 21.87% (Table1).However in 81.25 % the lower most diaphragmatic crural attachment extended to L3 vertebra on right side and L2 vertebra in 78.12 % on the left side (Table2). Right crura in 21.87 % and left crura in 18.75 % blended with anterior longitudinal ligament (Table3). The present study correlate with the study of Imtiaz Ahmad et al where on the right side crural attachment extend upto L3 in 73.3%, and on left side upto L2 in 64.4 %. On the right side in 24.4% and left side in 22.2% crura blended with the anterior longitudinal ligament[20].

CONCLUSION

There is a marked anatomical variation in the attachment of diaphragmatic crura. Recognition of variant will be helpful in diagnosis and treatment of hiatal hernia, crural tumour and crural injury.

Author's Contribution:

Concept & Design of Study: Zahid Hussain
Drafting: Munila Shabnam Khattak
Data Analysis: Sadaf Ambreen, Shahbuddin
Revisiting Critically: Abdul Sahib Khan
Final Approval of version: Zahid Hussain

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Pearce JM. Henry Gray's Anatomy. Clinical Anatomy. United States 22(3):291-5.
2. Susan S. Gray's Anatomy. 40th ed. Churchill Livingstone: Spain; 2008.p.1007-1009.
3. De Troyer A, Sampson M, Macklem PT. Action of the costal and crural parts of the diaphragm on the rib cage in dog. J Appl Physiol 1982;53:30-39.
4. Biancani P, Zabinski M, Kerstein M, Behar J. Lower esophageal mechanics; anatomic and physiologic relationships of esophagogastric junction of cat. Gastroentral 1982;82:221-29.
5. Shehata R. The crura of diaphragm and their nerve supply. Acla Anat (Basel)1966;63:49-59.
6. Wylie J, Dodds MD, Dent J. Mechanisms of gastro esophageal reflux in patients with reflux esophagitis. Eng J Med 1982; 307:1547-1552.
7. Altschuler SM, Boylejt, Nixon TE, Pack AL, Choens. Simultaneous reflex inhibition of lower esophagus sphincter and crural diaphragm in cats. Am J Physiol 1985; 249:G586-G591.
8. Pickering M, Jones JFX. The diaphragm: two physiological muscles in one. J Anat 2002; 201(4): 305-12.
9. Kahrilas PJ, Wus Lin S, Pouderoux P. Attenuation of esophageal shortening during peristalsis with hiatus hernia. Gastroentral 1995;109(6):1818-1825.
10. Mital RK, Sivri B, Schirmer BD, Heine R. Effect of cruralmyotomy on the incidence and mechanism of gastroesophageal reflux in cat. Gastroentral 1993; 105(3):740-747.
11. Allan DW, Greer JJ. Embryogenesis of phrenic nerve and diaphragm in fetal rat. J Comp Neurol 1997;382:459-68
12. Moor KL, Persaud T. Development of the diaphragm in the developing human: clinically oriented embryology. 7th ed. Elsevier: USA; 2003.p.192-197.
13. Hammond CG, Gordon DC, Fisher JT, Richmond FJ. Motor unit territories supplied by primary branches of the phrenic nerve. J Appl Physiol 1999;86:779-786.
14. Loukas M, WartmannCh T, Tubbs RS, Apayelin N, Louis RS, Gupta AA, et al. Morphalogical

variations of diaphragmatic crura: a correlation with pathologic process of esophageal hiatus. Folia Morphol 2008; 67:273-279.
15. Restrepo CS, Eraso A, Ocazionez D, Lemos J, Martinez S, Lemos DF. The diaphragmatic crura and retrocrural space: normal imaging appearance, variants and pathologic conditions. Radiographic 2008;28,n.5:1289-1305.
16. Wood JH, Bognar B. Muscular hypertrophy of left diaphragmatic crus: an unusual cause of paraspinalmass. J Thoracic Imaging 1998;13:144-145.
17. Yeh HC, Halton KP, Gray CE. Anatomic variations and abnormalities in the diaphragm seen with US. Radiographics 1990;10:1019-1030.
18. Leung JC, Nance ML, Schwab CW, Miller WT. Thickening of diaphragm: a new computed tomography sign of diaphragm injury. J Thorac Imaging 1999; 14:126-129.
19. Mazhar S, Mogotlane RA, Ahmad F. Crura of the diaphragm: variation in their anatomy. J Anatomy 1988; 33(2):499-50.
20. Ahmad I, Kaukab N, Ikram M, Hussain A. Anatomical variations of diaphragmatic crura.J. Rawalpindi Med Coll 2011;15:120-122.