Case Report

http://dergipark.org.tr/en/pub/anatomy
Received: June 1, 2021; Accepted: August 10, 2021
doi:10.2399/ana.21.946049

anatomy
An International Journal of Experimental and Clinical Anatomy

Renal artery piercing the diaphragmatic crus

Kaan Esen, Yüksel Balcı

Department of Radiology, School of Medicine, Mersin University, Mersin, Turkey

Abstract

The anatomical variations of renal artery related with number, branching pattern and origin level have been well described. The variations regarding the course of the artery are limited and mainly related with its relation of vena cava inferior. However, diaphragmatic crus is also on the pathway of renal artery and this relationship might also have variations. Different from its usual precrural position, there are a few cadaveric dissections reported as retrocrural or transcrural renal artery. This is the report of a rare variant of renal artery course, where it was crossing between the fibers of diaphragmatic crus detected on CT angiography.

Keywords: CT angiography; diaphragmatic crus; renal artery; variation

Anatomy 2021;15(2):175–177

Introduction

Vertebral attachments of diaphragm are called as crura.[1,2] At the caudal portion, the tendinous part of the right and left crus attaches to the first three and two lumbar vertebrae respectively.[2,3] Above the celiac trunk, the two crura conjoin to form an arch called as median arcuate ligament.[3] Anomalies and variations of diaphragmatic crus are usually asymptomatic.[3] Duplication is the most commonly reported variation of diaphragmatic crus and reported to be usually on the right side. However, the discontinuity between the crura of the diaphragm and lateral arcuate ligament has been defined as a normal variant. Herein, we report a rare anatomical variation related with diaphragmatic crus and the course of renal artery.

Case Report

A 55-year-old man presented to the emergency department with complaints of sudden and severe chest pain. On initial examination, myocardial ischemia and aortic dissection were thought previously in the differential diagnosis. The blood pressure of the patient was 150/80 mmHg. Following the electrocardiogram and the blood tests, patient underwent a CT angiography with a 64-slice scanner (Toshiba Aquilion 64, Toshiba Medical Systems, Tokyo, Japan). One hundred cc nonionic contrast material was administered through an antecubital venous catheter. Scanning was performed from the top of the aortic arch to the bifurcation level of femoral arteries. Multiplanar reformatted and three-dimensional images were created. A dissection extending from the root of aorta to the iliac arteries were detected. There was an accessory right renal artery originating from the true lumen that was feeding the lower pole of right kidney. However, the right main renal artery, originating from the false lumen, was crossing between the muscle fibers of the right diaphragmatic crus along its course (**Figures 1** and **2**). The origin level of right renal artery was at the level of L1. Additionally, renal artery was compressed with the fibers of diaphragmatic crus (**Figure 3**). The left renal artery was normal. Patient underwent an emergency operation but unfortunately had died.

Discussion

Variations that may affect the relationship of renal artery and diaphragmatic crus is limited and generally have been reported in renal artery entrapment cases.[4,5] For example, in a cadaveric dissection, Shruthi[6] reported a renal artery which was passing posterior to the crus of the diaphragm. In 1924, Guinane[7] reported a case in which enlarged right crus was pierced by the right renal artery. Renal artery, in that case, was entirely covered by the muscular fibers of the crus. Martin[8] defined a right renal artery passing through a cleft in the right crus of

diaphragm in 1971. Renal artery was at its normal level and there was a separation persisted into the muscular portion of the crus for a distance of 4 to 5 cm, so that two separate bundle of muscle fibers could be distinguished. Our case showed similarity to the one described by Martin,[8] however was detected with CT angiography.

The renal artery in our case was piercing the crus at its normal level and compressed by the crus of the diaphragm where it was passing. At the caudal portion of renal artery there were two separate crura. Herein, one can say that this might also be entitled as an accessory or duplicated crus. Different forms of duplication in cadavers have been described. Sirasanagandla et al.[2] reported a duplicated crus which were widely and completely separated. In another case reported by Vadgaonkar et al.,[1] the accessory right crura arosing from the right psoas major were separated from the normal crus by an interval of 0.7 cm throughout its length except distal attachment. The terms of partial or complete separation have been used by different authors. In the light of previous definitions, a cleft in the right crus may be used rather than a duplicated crus for the present case because of the position of renal artery.[8] Although there was a separation of the crus, this was not complete and both of the distal ends were attached to L2 and L3 vertebrae consecutively.

The diaphragm start developing during 4th to 12th weeks of embryonic life and classified as costal and crural. The crural diaphragm develop from myoblasts growing into the dorsal mesentery of the esophagus.[1,3,9] However, the kidney reaches its location between the 6th and 9th weeks and renal arteries arise from lateral splanchnic arteries during the development of mesonephric kidney.[10] As the kidneys migrate, they are vascularized by a succession of transient aortic sprouts that arise at progressively higher levels.[10] Various mechanisms have been defined to explain the anomalies of diaphragm, kidney and its vasculature. Partial duplication of the diaphragm that may involve the crura is thought to result from improper timing in the interaction of the lung buds and septum transversum.[3] Considering the time of formation of the crus and renal arteries, the arrangement of this variation might also be related with the timing of renal arteries' occurrence at their normal localization. Therefore, the position of renal artery and the cleft of the diaphragmatic crus suggest that renal artery forms before diaphragmatic crus.

Conclusion

The clinical importance of this variation is the potential of causing renal artery entrapment which is an infrequent

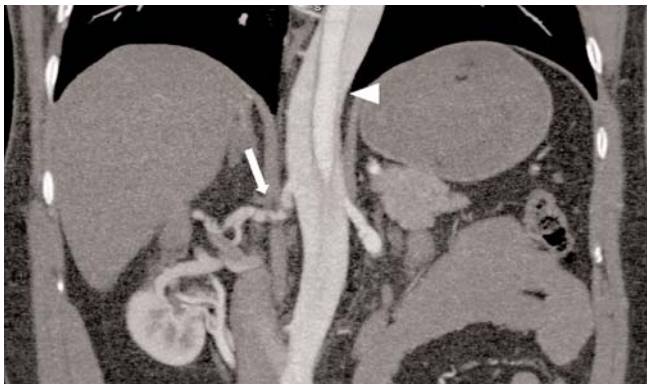

Figure 1. Coronal maximum intensity projection (MIP) CT image shows the stenosis of right renal artery (**arrow**). Note the dissection of aorta (**arrowhead**).

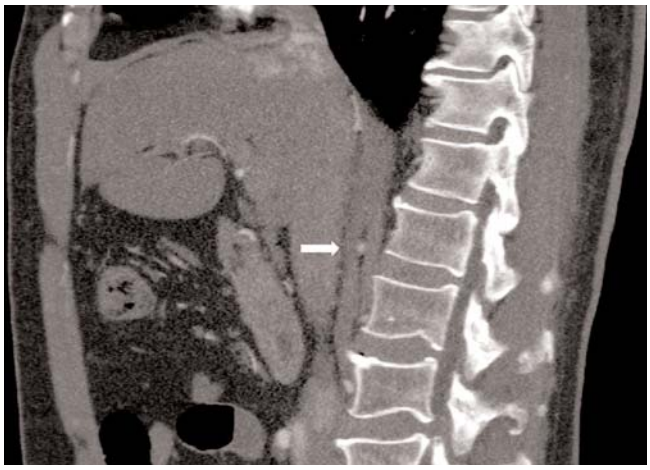

Figure 2. Renal artery piercing the diaphragmatic crus on sagital MIP image (**arrow**).

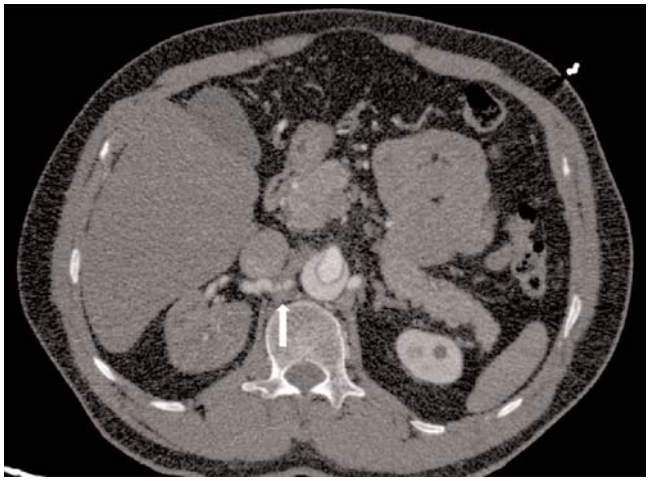

Figure 3. Axial MIP CT image shows the entrapment and critical stenosis of right renal artery (**arrow**). Note the ostial compression of left renal artery with left diaphragmatic crus and the nonenhancing upper pole of right kidney.

cause of renovascular hypertension.[6] Thony et al.[5] classified the entrapments as ostial and truncular with respect to the length of compression at which renal artery is in normal precrural localization. While the retrocrural and transcrural course of renal artery is very rare, a classification of entrapments with respect to renal artery course may also be defined. Although we did not have a chance to explore a relationship between the hypertension and renal artery stenosis in our case, this entity has a clinical interest. We suggest using cross-sectional CT angiography imaging to evaluate the variations that are under risk of compression.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

KE: Project development, data collection, manuscript writing; YB: Literature review.

Ethics Approval

Not applicable.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Vadgaonkar R, Murlimanju BV, Prabhu L, Rai AR, Nayak SR, Pinto C. Accessory crus of diaphragm-a human morphological case report. Journal of Morphological Sciences 2013;30:140–2.
2. Sirasanagandla SR, Nayak SB, Bhat KM, Surendran S, Regunathan D, Kumar N, Shetty SD, Patil J. Duplicated right crus of the diaphragm: a cadaveric case report. J Can Chiropr Assoc 2014;58:39–44.
3. 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. Radiographics 2008; 28:1289–305.
4. Gaebel G, Hinterseher I, Saeger HD, Bergert H. Compression of the left renal artery and celiac trunk by diaphragmatic crura. J Vasc Surg 2009;50:910–4.
5. Thony F, Baguet JP, Rodiere M, Sessa C, Janbon B, Ferretti G. Renal artery entrapment by the diaphragmatic crus. Eur Radiol 2005;15:1841–9.
6. Shruthi BN. Unilateral entrapment of the renal artery by diaphragmatic crus. National Journal of Medical Research 2013;3:412–3.
7. Guinane FR. Two anomalies in the construction of the diaphragm. J Anat 1924;59:83–6.
8. Martin Jr DC. Anomaly of the right crus of the diaphragm involving the right renal artery. Am J Surg 1971;121:351–4.
9. Moore KL, Persaud TVN. Development of the diaphragm. In: Moore KL, Persaud TVN, editors. The developing human: clinically oriented embryology. 7th edn. Philadelphia (PA): Saunders; 2003. p. 192–7.
10. Park JM. Embryology of the genitourinary tract. In: Wein AJ, Kavoussi LR, Partin AW, Peters CA, editors. Campbell-Walsch Urology. 11th ed. Philadelphia (PA): Elsevier; 2016. p. 2823–48.

ORCID ID:
K. Esen 0000-0002-8404-7484;
Y. Balcı 0000-0003-1758-9600

Correspondence to: Kaan Esen, MD
Department of Radiology, School of Medicine, Mersin University, Yenişehir, 33110, Mersin, Turkey
Phone: +90 532 425 65 54
e-mail: kaanessen@yahoo.com

Conflict of interest statement: No conflicts declared.

 How to cite this article: Esen K, Balcı Y. Renal artery piercing the diaphragmatic crus. Anatomy 2021;15(2):175–177.