Case Report

Anatomical Variation of the Origin and Course of the Right Renal Artery

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Abstract

The anatomy of renal vascular variants plays an important role during planning of major procedures involving retroperitoneal spaces. The present observation revealed the co-existence of arterial and venous variants on the right kidney. A single right renal artery originates from the abdominal aorta at the level of fourth lumbar vertebrae and ascends superolaterally towards the hilum of the right kidney, arching above the inferior vena cava, leading to compression of the largest retroperitoneal vein. Accompanying this, a variant anastomosing vein connecting the right renal vein and the inferior vena cava was also observed. Understanding the existence of these variants is of important to clinicians, surgeons, urologists, radiologists, and cardiologists during their routine procedures such as nephrectomy, kidney transplant, and management of inferior vena cava syndrome and deep venous thrombosis.

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Keywords: right renal artery, inferior vena cava, variants, compression

Background

Classically each kidney receives arterial blood supply from a single renal artery that arises perpendicularly from the lateral aspects of the abdominal aorta at the level between the 1st and 2nd lumbar vertebrae,[1,2] immediately inferior to the origin of the superior mesenteric artery. Attributable to the anatomical relation of each kidney to the abdominal aorta, the left renal artery is shorter compared to the right renal artery. As a result, the right renal artery has to run across the midline to supply the right kidney. On this course, it passes posterior to the inferior vena cava, right renal vein, head of the pancreas, and descending part of the duodenum.[3,4]
Morphological variations on the arterial supply of the kidney has been reported previously involving the number and unusual branches originating from it.[2,3,5] These variations are incidentally observed during routine procedures. However, the present report aims to describe a variant observation on origin, position and course of the right renal artery, which is different from the aforementioned anatomical relations and variants.

A routine dissection of the posterior abdominal wall (retroperitoneal) was performed on adult male cadaver to explore the blood supply of the right and left kidneys. Parietal peritoneum was removed from the posterior abdominal wall to expose retroperitoneal organs including the kidneys, abdominal aorta and inferior vena cava. A variant arterial supply was observed on the right kidney with unusual position, course and origin of the renal artery (Figure 1).

The right renal artery originated on the anterolateral part of the abdominal aorta at the superior margin level of the 4th lumbar vertebrae (L4). It is Located 4.4 cm below the origin of the superior mesenteric artery (SMA) and 0.8 cm above the origin of the inferior mesenteric artery (IMA) (Figure 1 and Figure 3).

It had an external diameter of 0.6 cm with a total length of 4.8 cm and an early division at 0.8 cm before reaching the hilum of the right kidney, giving off two branches: large posterior and smaller anterior divisions (Figure 2).

From its origin on the right abdominal aorta, it ascends in an oblique direction, crossing above the anterior surface of the inferior vena cava (IVC), forming a 45-degree angle at its origin point, then moves superolaterally, arching in front of the IVC towards the hilum of the right kidney. It creates a triangular space as it leaves the right lateral border of the inferior vena cava. This triangular space has a medial border formed by the right lateral margin of the IVC, the base formed by the superior margin of the right renal artery, while the lateral border is formed by the medial margin of the obliquely directed right renal vein (Figure 1 and Figure 2). At the summit of the triangle, an anastomosing vein with an external diameter of 0.2 cm and 0.8 cm long joins the right renal vein with the IVC, separating the apex into a sub-triangle (Figure 2). This vein originated from the ventromedial margin of the obliquely positioned right renal vein and enter the IVC on its posterolateral margin on the right side.

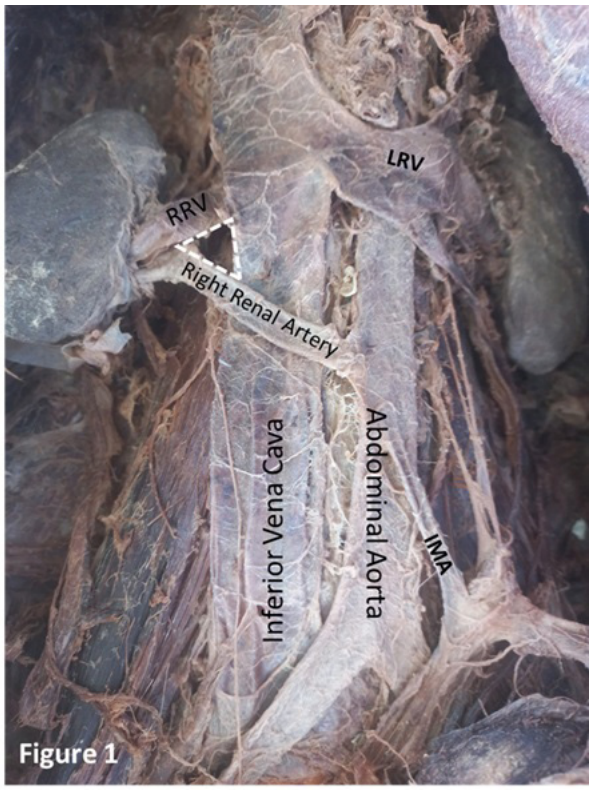


Figure 1

Figure 1. Posterior abdominal wall (retroperitoneal) showing the origin, position and course of the right renal artery in relation to the right kidney. The artery passes anterior to (above) the inferior vena cava at an angle (oblique). Note the triangular space (white dotted space) formed by the path of the artery.
RRV: right renal vein; IMA: inferior mesenteric artery .

Figure 2. Retroperitoneal vessels showing the anastomosing vein (dotted white arrow) between the right renal vein and the inferior vena cava (IVC), early division of the right renal artery (RRA) into anterior (white arrow) and posterior (black asterisks) divisions. The red dotted circle indicates the position of the Superior Mesenteric artery; the blue dotted circle: celiac trunk.

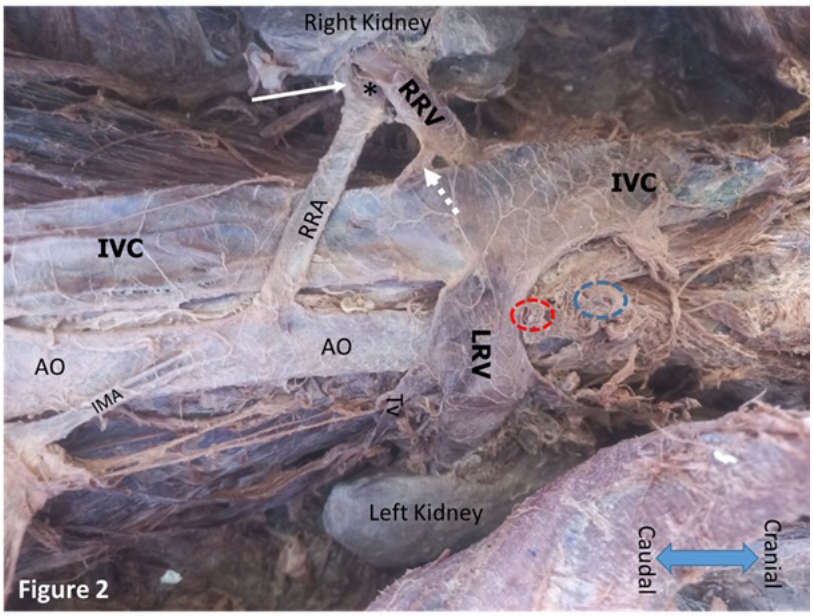
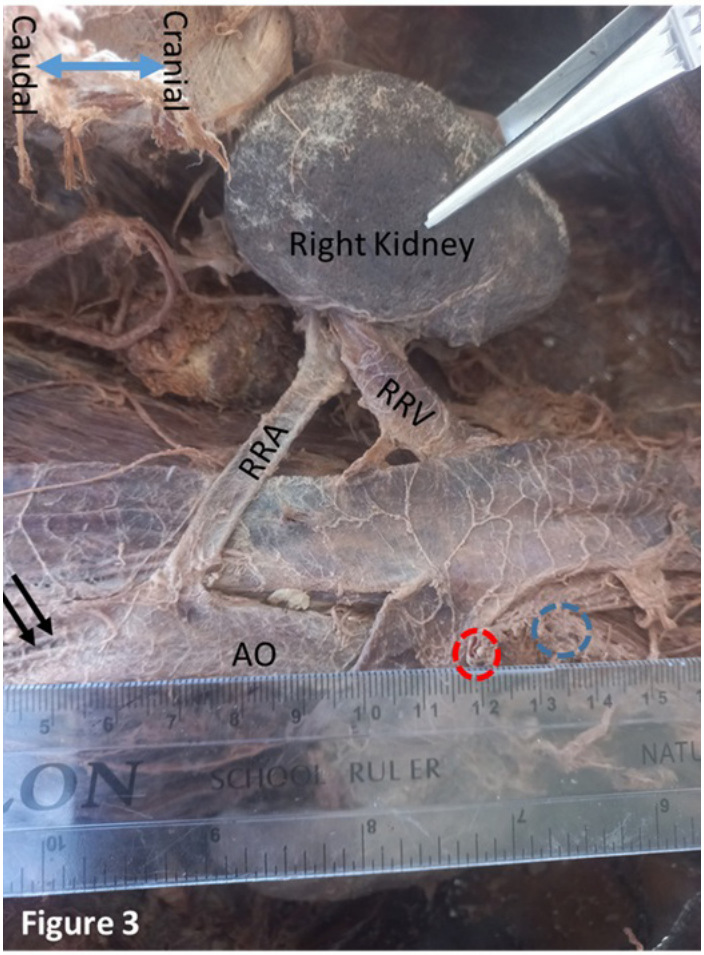


Figure 3. Retroperitoneal structures showing distances among major arterial branches of the abdominal aorta (AO). Blue dotted circle: Celiac trunk artery; Dotted Red Circle: Superior mesenteric artery; Arrow heads: Inferior mesenteric artery; RRA: right renal artery; RRV: right renal vein.



Discussion

Knowledge of existing variants on vascular supply to the kidneys and their relation to other abdominal vessels is important in planning clinical procedures on the retroperitoneal space.

Usually, the right renal artery originates at the level between L1 and L2, which is not the case in the present study, where it arises at the superior margin of L4 level and courses upwards to the right kidney hilum. This position is commonly associated with the origin of polar renal arteries.

On its path, the right renal artery arched over the inferior vena cava, which is a novel observation of clinical importance. This relation may cause potential compression of the IVC against the posterior abdominal wall, leading to obstruction of venous return. Compression and obstruction may lead to the development of the Inferior Vena cava syndrome, that affects blood return to the heart and decreased cardiac output.

On other hand, compression may also cause turbulence by disturbing the blood flow that might lead to thrombus formation resulting in deep venous thrombosis (DVT).

Endothelium of the blood vessels contains thromboregulators,[6] that prevent thrombus formation. However, when the IVC is compressed by the overlying right renal artery, the turbulent blood flow may disturb the integrity of the IVC-endothelium leading to tissue factor pathway platelet activation, thereby initiating the formation of thrombus,[6,7]

The triangular space formed as a result of variant course of right renal artery has potential clinical implications since it contains anastomosing branch connecting inferior vena cava and right renal vein, that might be severed during routine procedures. Existence of this accessory connection between renal vein and IVC (venous venous anastomosis) is a novel observation that has not been reported previously. Hence, understanding this venous shunt is important for planning surgical procedures that involves the renal veins such as nephrectomy and kidney transplant.

Conclusion

Existing novel anatomical variants involving renal vascular supply and inferior vena cava are attributed to modifications of the developmental processes and are of clinical importance to urologists, radiologists, surgeons and cardiologists undertaking routine procedures on the retroperitoneal space, such as nephrectomy, kidney transplant, and management of the inferior vena caca syndrome.

Authors' contribution

GJM: designed the study, main conceptual ideas, prepare the original draft and reviewed the manuscript.

Conflict of interest declaration

The author declares that there is no conflictof interest that could be perceived as prejudicing the impartiality of this work.

References

1. Ozkan U, Oguzkurt L, Tercan F, Kizilkilic O, Koc Z, Koca N. Renal artery origins and variations: angiographic evaluation of 855 consecutive patients. *Diagnostic and Interventional Radiology.* 2006;12(4):183-6. PMID: 17160802
2. Aremu A, Igbokwe M, Olatise O, Lawal A, Maduadi K. Anatomical variations of the renal artery: a computerized tomographic angiogram study in living kidney donors at a Nigerian Kidney Transplant Center. *Afri Health Sci.* 2021;21(3). 1155-1162. https://dx.doi.org/10.4314/ahs.v21i3.24
3. Listmann M, Tubbs RS, Iwanaga J, Oskouian RJ, Moisi M (eds.), "Chapter 19 - The Abdominal Aorta", Surgical Anatomy of the Lateral Transpsoas Approach to the Lumbar Spine. *St. Louis: Elsevier; 2020. p. 185–188, ISBN 978-0-323-67376-1* https://doi.org/10.1016/B978-0-323-67376-1.00019-7
4. Jones J, Yu Y, Figueiredo T, et al. Inferior vena cava. *Reference article, Radiopaedia.org (Accessed on 02 Oct 2024)* DOI: https://doi.org/10.53347/rID-5730
5. Munnusamy K, Kasirajan SP, Gurusamy K, Bolshetty GR, Chakrabarti S, Annadurai P, Miyajan ZB. Variations in Branching Pattern of Renal Artery in Kidney Donors Using Ct Angiography. *J Clin of Diagn Res.* 2016; 10(3):AC01-AC03. DOI: 10.7860/JCDR/2016/16690.7342
6. Furie B, Furie BC. "Mechanisms of thrombus formation". *New England Journal of Medicine.* 2008; 359 (9): 938–949. doi:10.1056/NEJMra0801082. PMID 18753650.
7. Kushner A, West WP, Khan Suheb MZ, et al. Virchow Triad. [Updated 2024 Jun 7]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK539697. Accessed September 2024