Case Report

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Renal Vessels: Anatomical Variations

Anatomy Section

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ABSTRACT

Variations of renal vessels are more significant due to gradual increase in interventional radiological procedures, urological and vascular operations and renal transplantation. Usually, the renal arteries take origin from the lateral aspect of aorta below the origin of superior mesenteric artery at the level of L2 vertebra. During routine dissection of 60-year-old female cadaver, we found double renal arteries with double renal veins for the right kidney and in the left kidney, there were double renal arteries and two renal veins coming out from the hilum and they joined to form the main left renal vein, which passed in front of the aorta. The incidences of variation of renal arteries are about 30%. Knowledge of the unusual variations of the renal arteries is necessary for selection of kidney donor as well as during nephrectomy and segmental resection and could help the clinician in its prior recognition and due protection accordingly during renal surgeries.

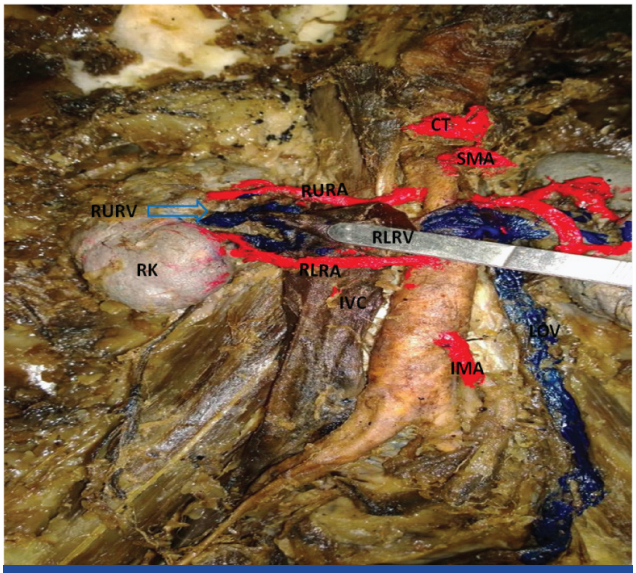
Keywords: Nephrectomy, Vascular operations, Vertebra

CASE REPORT

During the gross anatomy dissection of the abdomen of an approximately 60-year-old female cadaver, we observed variations in the renal vessels. On the right side, there was double renal arteries and double renal veins and on the left side, there was double renal arteries and two renal veins coming out from the hilum and they joined to form the main left renal vein, which passed in front of the aorta. On the right side, upper renal artery was arising from the abdominal aorta at the L1 level just below the superior mesenteric artery and passes behind the inferior vena cava and divides into apical and anterior segmental branches before entering into the upper part of the hilum of right kidney [Table/Fig-1].

Lower renal artery was arising from the abdominal aorta at the level of L2, then, crossed the inferior vena cava anteriorly and divided into middle, posterior, inferior segmental branches before entering into the lower part of the hilum of the right kidney [Table/Fig-1].

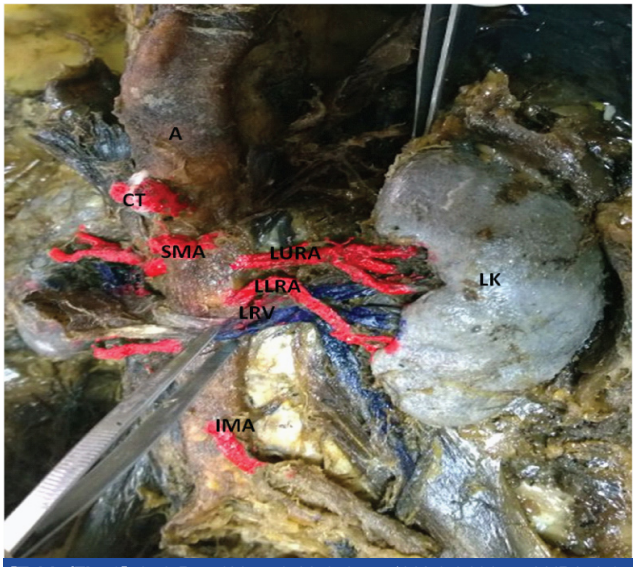
On the left side, upper renal artery was arising from the lateral part of the abdominal aorta at the level L1 and divided into three segmental apical, anterior, middle branches before entering into the hilum. Left lower renal artery was arising from the lateral part of the abdominal aorta at the upper border of L2 and behind the left renal vein, then runs upwards and winds around the upper border of left renal vein, crossed it anteriorly and divided into posterior and inferior segmental



[Table/Fig-1]: Right Renal Vessels Variations. (CT- celiac trunk, SMA- superior mesenteric artery, RURA- right upper renal artery, RLRA- right lower renal artery, IMA- inferior mesenteric artery, RURV- right upper renal vein, RLRV- right lower renal vein, IVC- Inferior vena cava, RK- right kidney)

branches before entering into the lower part of the hilum of left kidney [Table/Fig-2]. On the right side, two renal veins were observed which were coming out from the hilum of the kidney and draining into inferior vena cava and ovarian vein followed as usual course [Table/Fig-1]. On the left side, there were two

renal veins coming out from the hilum of left kidney and they joined to form the main left renal vein, which passed in front of the aorta. The lower vein rather than the main left renal vein received the ovarian vein of the left side [Table/Fig-2].



[Table/Fig-2]: Left Renal Vessels Variations. (LK- left kidney, LURA- left upper renal artery, LLRA- left lower renal artery, LRV- left renal vein, CT- celiac trunk, SMA- superior mesenteric artery, IMA- inferior mesenteric artery, A- aorta)

DISCUSSION

Knowledge of the occurrence of variations in the origin, course, relations and branching pattern of renal vessels is very essential in performing surgical procedures including transplantation of kidneys during infancy, childhood and in adults. In 70% of the individuals, each kidney is supplied by a single renal artery and in 30% of individuals, accessory renal arteries are common and usually arise from the aorta above or below the main renal artery and follow it to the renal hilum. They are regarded as persistent embryonic lateral splanchnic arteries [1].

Renal veins variations are not as common as arteries (incidence – 0.8 to 6 %). Presence of additional renal vein has been reported to occur in 14% cases [2,3]. Satyapal (1995) has named any extra vein other than renal vein emerging out of kidney and draining separately in the inferior vena cava as 'additional' renal vein and classified these kidneys as type-3, using the drainage pattern of primary renal vein tributaries and renal vein proper as a basis [3]. Reviewing previous articles, we found that presence of additional renal vein was ten times more common on the right as compared to the left side. The renal vascular segmentation was discovered by John Hunter in 1794, but a detailed account was given in 1950's by Corrosion Cast studies. There are five defined arterial segments: apical, superior, middle, inferior and posterior. The anatomical knowledge of these segments is important while performing nephrectomies [4].

Budhiraja et al., observed prehilar multiple branching of renal arteries in 11 (11.66%) cases, duplication of renal arteries in eight cases (8.33%), superior polar arteries in seven cases (6.66%). Prehilar branches were directed towards apical, superior, middle, inferior and posterior vascular segment of kidney [5]. In the present case, inferior renal artery on the right side was seen to pass superficial to inferior vena cava after taking origin from the lateral part of aorta at the level of L3. Similar case was observed by Rajesh and Mane (2013) [6].

According to Hollinshead, the level of origin of renal artery is important topographically as right renal arteries which arise at a lower level typically pass in front of the inferior vena cava instead of behind it. He also gave a developmental explanation that the inferior vena cava below the level of kidney usually develops from a dorsally placed supracardinal system of veins while that at the level of kidney develops from a ventrally placed subcardinal system of veins. Thus, inferior vena cava is placed ventral to the right renal artery at a higher level and dorsal to it at a lower level [7].

The renal veins are interconnected within the kidney and if one renal vein is occluded, the remaining renal vein will continue to drain the entire kidney. Unlike the arteries, the venous tributaries anastomose within the kidney and there are minor anastomosis throughout the fibrous capsule with veins that are not tributaries of renal veins, but due to insufficiency of anastomosis, sudden occlusion of a vein may cause necrosis of the whole kidney [8].

Mandal et al., 2013 and Moore and Persaud (2002) reported emergence of two renal veins at the hilum of right kidney, which drained separately into inferior vena cava which is similar to our case [9,10]. Satypal classified the drainage patterns of the renal veins. The present case was grouped according to the classification as group III with an accessory renal vein. He reported that the right accessory renal veins were more common than the left accessory renal veins which are similar to our case [11].

Embryological explanation: Presence of accessory renal arteries and abnormalities of renal arteries are due to the various developmental positions of the kidney. The kidneys begin their development in the pelvic cavity. During further development, they ascend to their final position in the lumbar region. When the kidneys are located in the pelvis, they are supplied by the branches of internal iliac or common iliac arteries. While the kidneys ascend to the lumbar region, their arterial supply also shifts from common iliac artery to the abdominal aorta. Accessory renal arteries originate from the abdominal aorta either above or below the main renal artery and reach the hilum [4]. It is important to be aware that accessory renal arteries are end arteries; therefore, if an accessory artery is ligated or damaged, the part of kidney supplied by it is likely to become ischaemic.

During development of inferior vena cava, the "renal collar" form a circum aortic venous ring, being contributed anteriorly by subcardinal veins and intersubcardinal anastomosis, posteriorly by supracardinal veins and inter supracardinal anastomosis and on each side by supracardinal-subcardinal anastomosis. The bilaterally symmetrical cardinal venous system converts into unilateral rightsided inferior vena cava at around eight weeks. IVC is established in the right of aorta consequent to this "venous shift" to the right of the body. At this time, two renal veins are present on each side, one on the ventral plane and another dorsal to it. In the right side, one renal vein opens into lateral portion of the renal collar and the other opens more dorsally towards cranial part of the supracardinal vein. With further development, there is confluence of the two tributaries producing a single vessel that connects with the lateral portion of renal collar [12]. The persistence of these two veins may result in the additional renal vein of right side as seen in present case. These shifting of venous arrangement to the right "discourage" the retention of any additional left sided renal veins, which would be required to reach across the aorta. Furthermore, complex embryogenesis of left renal vein would further "discourage" this process.

CONCLUSION

Anatomical variations in the origin of the renal arteries may have importance for the urologists while performing nephron-preserving surgery, kidney transplantation and the management of renal vascular hypertension. Knowledge of anomalous vessels serves as the important guidelines before surgery, reduces the risk of trauma to the vessels and ensures through vascular ligation and anastomosis. So, to avoid any vascular complication, multi detector computer tomography (MDCT), angiography and arteriography should be performed prior to every nephrectomy.

REFERENCES

[1] Parmar JK, Gujar S, Vikani S, Kubavat D, Nagar SK, Wani IN, Parmar KM, Bondre KV. A cadaveric study of variations in renal artery. *International Journal of Biomedical and Advance Research*. 2012;3(11):15-17.

[2] Pick JW, Anson BJ. The inferior phrenic artery: origin and suprarenal branches. *Anat Rec*. 1940;78:413-27.

[3] Satyapal KS. Additional renal vein: incidence and morphometry. *Clinical Anatomy*. 1995;8:5-55.

[4] Standring S. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 40th edition. New York. *Elsevier Churchill livingstone*. 2005:1274-75.

[5] Budhiraja V, Rastogi R, Asthana AK. Renal artery variations: embryological basis and surgical correlation. *Romanian Journal of Morphology and Embryology*. 2010;51(3):533-36.

[6] Rajesh RV, Mane AB. Anatomical variations of the renal arteries in humans. *Int J Pharm Bio Sci*. 2013;4(2):728-34.

[7] Hollinshead WH. Anatomy for surgeon. The thorax, abdomen and pelvis. In: The kidneys, ureters and suprarenal glands. Paul B, Horber. Inc. *Medi Book Deptt of Harper and Brithers. Newyor*k. 1958;2:533-47.

[8] Dhar P. An additional renal vein. Clincal Anat. 2002;15:64-66.

[9] Mandal S, Mandal P, Basu R. Bilateral accessory renal arteries, additional right renal vein and retroaortic left renal vein – A case report. *International Journal of Health Sciences and Research*. 2013;3:88-93.

[10] Moore KL, Persaud TVN. The Developing Human: Clinically Oriented Embryology. 9th edition. *Philadelphia. WB Saunders*. 2002:293.

[11] Satyapal KS. Classification of drainage pattern of renal veins. *J Anat*. 1995;186:329-33.

[12] Willams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE, et al. Gray's anatomy; in: embryology and development. 38th ed. *Churchill Livingstone London*. 1995:324-26.

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