

Bilateral Duplication of Renal Artery in a Cadaver and its Clinical Implications: A Case Report

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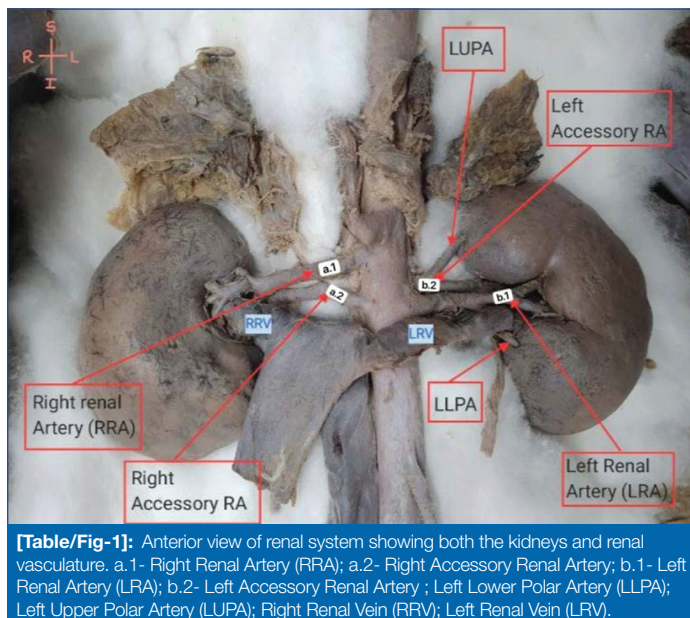
ABSTRACT

In normal adult renal system, the renal artery originates from the abdominal aorta at the level of the lower border of L1 vertebrae, just below the origin of the superior mesenteric artery, one on each side. In 15-30% of the population, rare variation in origin and distribution pattern of renal artery can be seen. These variations may be attributed to anomalies in the development of the vascular system. These anomalies lead to the emergence of accessory or multiple renal arteries, causing significant variations in normal anatomical pattern. The aim of present study was to report the presence of double renal arteries on both sides, which has about 10% occurrence amongst all renal artery variations. Most commonly, double arteries are found unilaterally in approximately 30% of cases. Also, in the present case, the renal system was perfused by additional prehilary branches and polar arteries arising from either of the renal arteries. Hence, it is a rare entity. The occurrence of such variation in the vasculature of renal arteries has significant clinical implications. The knowledge of presence of aberrant or multiple renal arteries is significant for urologists, physicians, radiologists and surgeons, while performing surgeries related to kidneys, adrenal glands and associated structures.

Keywords: Abdominal aorta, Aberrant renal arteries, Renal transplant, Retroperitoneum

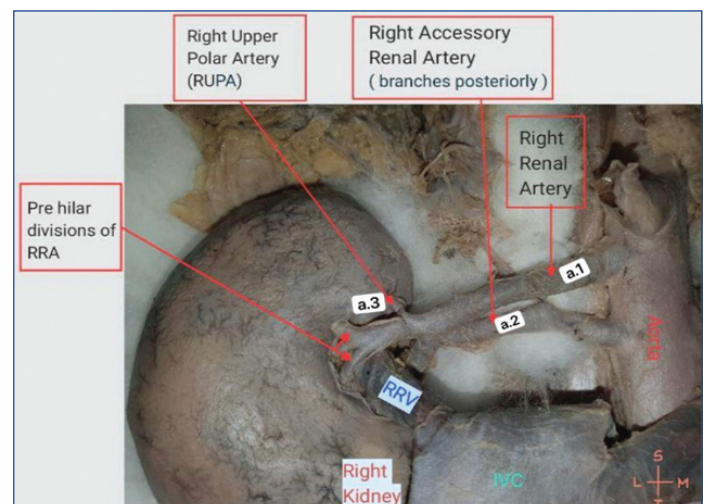
CASE REPORT

During routine cadaveric dissection of posterior abdominal wall in the Department of Anatomy, SMBT Institute of Medical Sciences and Research Centre, Nashik, Maharashtra, an unusual variation of bilateral renal arteries was found. In this male cadaver, two renal arteries were found to be originating from the abdominal aorta bilaterally. This bilateral duplication of renal arteries was found along with prehilary branches and polar branches [Table/Fig-1].



[Table/Fig-1]: Anterior view of renal system showing both the kidneys and renal vasculature. a.1 - Right Renal Artery (RRA); a.2 - Right Accessory Renal Artery; b.1 - Left Renal Artery (LRA); b.2 - Left Accessory Renal Artery; Left Lower Polar Artery (LLPA); Left Upper Polar Artery (LUPA); Right Renal Vein (RRV); Left Renal Vein (LRV).

On the right-side, main trunk of the Right Renal Artery (RRA) originated from abdominal aorta at the level of upper border of L1 vertebra and it gave rise to total three prehilary divisions/arteries, two divisions anteriorly and one division posteriorly along with Right Upper Polar Artery (RUPA) (anterior) to upper pole of right kidney. Right Accessory RA originated from the abdominal aorta about 2 cm below the origin of main trunk and ran behind Right Renal Vein (RRV) and gave a posterior branch RUPA (posterior) and a hilar branch entering the hilum posterior to RRV [Table/Fig-2].



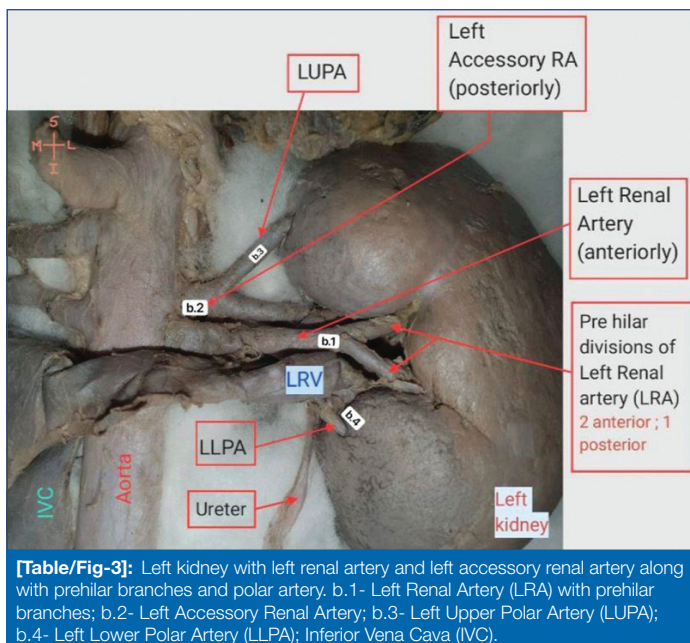
[Table/Fig-2]: Right kidney with right renal artery and accessory right renal artery along with prehilary branches and polar artery. a.1 - Right Renal Artery (RRA) with prehilary branches entering hilum; a.2 - Right Accessory Renal Artery; a.3 - Right Upper Polar Artery (RUPA); Inferior Vena Cava (IVC); Right Renal Vein (RRV).

On the left side, main trunk of Left Renal Artery (LRA) gives rise to three branches in total- two prehilary divisions anteriorly and one division posteriorly with Left Lower Polar Artery (LLPA) to lower pole of left kidney. Left Accessory RA originated about 1 cm above the origin of the main trunk, and divided as soon as it emerged from abdominal aorta into Left Upper Polar Artery (LUPA) to upper pole of left kidney and a hilar branch reaching hilum, posterior to the main trunk [Table/Fig-3].

DISCUSSION

In normal human anatomy, the renal artery arises from the abdominal aorta at the level of lower border of L1 vertebra, one on either side. Each renal artery further divides into five segmental branches. Amongst five segmental branches, four segmental branches arise from anterior division and one from posterior division of renal artery after entering the hilum [1].

Variations in renal artery origin and distribution are a rare phenomenon. Occurrence of multiple renal arteries or accessory renal arteries is



seen in about 15-30% of the population, which may occur due to defect in embryological development of vascular system [2]. These accessory renal arteries originate from abdominal aorta either above or below the origin of the trunk of main renal artery either due to persistent lateral splanchnic arteries or due to persistent blood supply from lower segment arteries such as internal iliac arteries [2]. Main trunk of renal artery is considered as an artery which enters the substance of the kidney through the hilum and further divides into segmental branches within the kidney. Accessory renal artery is an artery that reaches the substance of the kidney at sites other than the hilum, occasionally in cases of prehilum branching as seen in above case, though at times they can enter into kidney through hilum too. In a few cases, main trunk can give off polar branches and may exhibit the prehilum branching pattern [3].

Normal embryological development of renal system begins in pelvis, which further ascends to its adult retroperitoneal position. At the beginning of foetal development, the blood supply to kidneys is derived by common or internal iliac arteries, but during ascent of kidneys to lumbar region, the blood supply also shifts from iliac vessels to branches of abdominal aorta [2]. During such changes like transition of position of kidneys, evolution of mesonephric duct, shifting of blood supply, etc., various congenital anomalies and variations can precipitate. Due to such embryological deviations aberrant renal arteries can arise from common iliac, internal iliac, mesenteric, inferior phrenic or other branches of the abdominal aorta [2].

Aristotle S et al., reported in their study, presence of bilateral supernumerary (accessory) renal arteries along with upper and lower polar arteries on right side. The pre-segmental branches were reported on both sides. In addition, presence of accessory renal vein on left side was seen which is rare in occurrence (1%). They also noted origin of inferior supra renal artery from accessory renal artery on left side which usually arises from the main trunk of renal artery, occasionally from gonadal, accessory renal artery, abdominal aorta, etc., [3]. In this case, double renal arteries on both sides were observed, on right only upper polar artery arising from main trunk of Right Renal Artery (RRA) was observed, also origin of inferior supra renal artery from accessory renal artery was seen in right renal system; in the above mentioned case, two accessory renal arteries were reported on the right while in this case only single accessory artery was reported on the right while in this case only single accessory artery was reported on both sides; whereas on left, upper polar branch was given by accessory renal artery and lower polar branch by main trunk of accessory renal artery. No notifiable anomaly was detected in renal veins as noted by Aristotle S et al., [3,4].

Clinical Implications

Accessory renal arteries do not significantly affect the normal function of the renal system, but they can play a major role during abdominal surgeries or invasive procedures involving retroperitoneal region. The knowledge of presence of such arteries is of utmost importance for surgeons, radiologists, nephrologists, etc., who deal with the renal system and abdomen while performing various invasive procedures. If such procedures are performed without prior radiological examinations, it can increase the risk of complications several folds. Thus, the presence of accessory artery is noteworthy for physicians and surgeons [5,6].

In cases of stenosis of main trunk, accessory arteries are found to be remarkable alternatives for blood supply to the substance of the kidneys. They thereby prevent ischaemia and infarction of renal tissues, which significantly contributes to the maintenance of osmotic balance of body fluids.

Normally, in the cases of aberrant renal arteries, they constitute an alternate additional supply along with main trunk of renal artery [7]. But as observations are made in few cases, as stated by Mir NS et al., they may constitute a sole supply to some part of kidney, which may get infarcted or diseased when such arteries are compromised. Hence, the significance of such arteries cannot be underestimated [2].

Renal blood supply is of utmost importance due to major role of kidneys in excretion and osmoregulation. Out of the total cardiac output a significant portion of about 20-25% is received by both kidneys [5]. Hence, compromise in renal vessels can affect the entire cardiovascular system and various clinical manifestations can be observed [5].

In cases of thrombosis of renal arteries or thrombosis near the ostia of arteries, the blood flow can retard leading to renal tissue ischaemia, which may further progress to coagulative necrosis of renal tissues, manifested as renal infarction. In cases of presence of accessory renal arteries, due to additional/alternate blood supply, chances of manifestations such as renal infarct are comparatively low [2].

Aneurysmal dilatations of arteries of retroperitoneal region are at high risk of rupture during surgeries involving retroperitoneum. Hence, dealing with such cases requires prior radiological examinations and vigilant surgical approach [8].

According to Kang K et al., presence of accessory renal arteries can result in the occurrence of primary hypertension, as the renal parenchyma perfused by accessory renal artery secrete higher amount of renin as compared to main renal artery, due to low perfusion pressure and small calibre of accessory vessels. Such elevated levels of renin act upon blood vessels via activation of Renin-Angiotensin-Aldosterone System (RAAS), causing excessive vasoconstriction and raising the blood pressure [9].

Hypertension can further produce various complications such as renal artery stenosis, aneurysm, dislodgement of thrombus causing thromboembolism and infarction of several organs supplied by end arteries [10].

CONCLUSION(S)

Aberrant renal artery provides alternate pathway for renal circulation which ensures uninterrupted blood supply to renal system. This is significant in cases of renal artery aneurysm, renal artery thrombosis, embolism, etc. The knowledge of presence of aberrant renal arteries is of great importance to surgeons because while performing various invasive surgical procedures like adrenalectomy, renal transplantation, renal artery aneurysm, etc. Lack of knowledge about such vessels may cause damage to these vessels during the procedure and result in severe haemorrhage. This may further result into various complications like shock, coma etc., and in severe cases death may occur. Hence, it is essential to undergo

proper radiological and clinical investigations before performing any invasive procedure involving retroperitoneal region to minimise possible complications.

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