

Case Report

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Navigating Renal Vascular Anomalies: A Case of Unilateral Arterial and Venous Duplication

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ABSTRACT

Blood supply of kidney is significant due to its integral function of excretion and osmoregulation. Each kidney supplied by single renal artery, lateral branch from the abdominal aorta and drained by single renal vein draining into IVC. Present case describes clinically significant variation of kidney with unilateral duplication of renal vessels. In this case, right kidney is supplied by the two renal arteries arising from the aorta and drained by two renal veins. The accessory renal artery here traversed between two renal veins. This can compromise the blood supply due to impingement. Duplication of renal vessels holds significance in renal surgeries as it will take longer time of anastomosis and can create technical difficulties during mobilization. Kidneys are most commonly transplanted organs, so knowledge of such variations which can affect the success of transplantation is significant. 20-25% of the cardiac output is received by kidneys so variations in the renal vessels affecting circulation may lead to clinical manifestations related to cardiovascular system too. Urologists, radiologists, and vascular surgeons need to know about these variations for segmental resections, renal transplantations, treatment of abdominal aorta aneurysms, renal stenosis treatment and clinical evaluation of renal vascular hypertension.

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Abbreviations

IVC - Inferior Vena Cava

RA - Renal artery

aRA - Accessory Renal Artery

RV1 - Renal Vein 1

RV2 - Renal Vein 2

AD - Anterior Division

PD - Posterior Division

SA1 - Segmental Artery 1

SA2 - Segmental Artery 2

SA3 - Segmental Artery 3

SV1 - Segmental Vein 1

SV2 - Segmental Vein 2

SA4 - Segmental Artery 4

SA5 - Segmental Artery 5

LA1 - Lobar Artery 1

LA2 - Lobar Artery 2

Introduction

Kidneys are the organs that are most commonly transplanted worldwide, followed by the liver and then the heart [1]. Approximately 1,57,494 organ transplants were performed worldwide in 2022, 1,02,090 (approximately 64.8%) of which were kidney transplants [1]. In about 70% of the individuals, each kidney is supplied by a single renal artery which arises from the abdominal aorta just below the origin of the superior mesenteric

artery [2,3]. Each renal artery branches into an anterior and a posterior division close to the hilum. The anterior division further divides into five segmental branches: the apical, upper, middle, and lower segmental arteries supplying each vascular segment of the kidney anteriorly. The posterior division supplies the posterior segment and parts of the apical and lower segments [2-4]. Each kidney is drained by single renal vein which is formed by union of segmental veins and drain into IVC [1].

The present case report describes unilateral duplication of vessels of the right kidney with right kidney supplied by two renal arteries and drained by two renal veins.

The levels of origin, course, and relations of renal arteries are less consistent [2,3]. Regarding the supernumerary renal arteries, terminologies like accessory renal artery and aberrant renal artery are mentioned in the literature review [5]. An accessory renal artery is an additional artery arising above or below the main artery accompanying it [main artery] while entering the kidney at the hilum. An aberrant renal artery is an artery that supplies the kidney but does not enter the hilum [6-8].

It is equally important to know the direction and position of the aberrant renal arteries. A vertical path of these arteries can lead to infarction and can be injured during surgical procedures [9,10]. The anatomical knowledge of supernumerary renal arteries is essential before performing any transplantation surgeries where microvascular techniques are employed to reconstruct the renal arteries. Not considering such variations would result in acute tubular necrosis,

decreased graft function, and rejection episodes [9-12].

Duplication of renal veins is generally an accidental finding in surgeries otherwise maximum times it goes unnoticed [13]. Double renal veins though create advantage of alternative path of blood circulation still can create major technical issues and longer time in renal surgeries [14,15].

Urologists, radiologists, and vascular surgeons need to know about the incidence of supernumerary renal vessels as they come across these situations during segmental resections, renal transplantations, treatment of abdominal aorta aneurysms, renal stenosis treatment, clinical evaluation of renal vascular hypertension [10-15].

Case Report

During routine cadaveric dissection of a sixty-five-year-old male cadaver, we found a different vascular pattern of the right kidney showing duplication of renal vessels. Normally, each kidney is supplied by a renal artery, which arises from either side of the abdominal aorta as a lateral branch. In the present case right, renal artery was arising from the ventral aspect of the abdominal aorta. To our surprise, in addition to the right renal artery, we found an additional artery- an aberrant renal artery (aRA) arising just above the right renal artery from the ventral aspect of the abdominal aorta (Figure 1).

The right renal artery (RA) divided into anterior and posterior divisions before reaching the hilum of the right kidney. The anterior division, instead of the normal four segmental branches, was divided into the three segmental branches- SA1, SA2, and SA3 (Figures 1 & 2) before entering the hilum. The posterior divided into two segmental branches- SA4 and SA5 (Figures 3 & 4) instead of one branch. The upper segmental branch- SA4 bifurcated into two lobar branches- LA1 & LA2 (Figures 3 & 4) and supplied the upper pole, whereas the lower segmental branch- SA5 entered the hilum.

This aberrant renal artery traversed downwards, crossing the main right renal artery and supplied the lower pole of the right kidney. This aberrant artery was seen passing between the two renal veins - RV1 & RV2 (Figures 1 & 2).

The two segmental veins- SV1 & SV2, united and formed RV1, which drained into the IVC. An additional vein- RV2, was found below RV1, draining into the IVC (Figures 1 & 2).

The present case is a unique combination of variations with double ventral right renal arteries and double right renal veins. The vascular pattern on the left side was found to be normal.

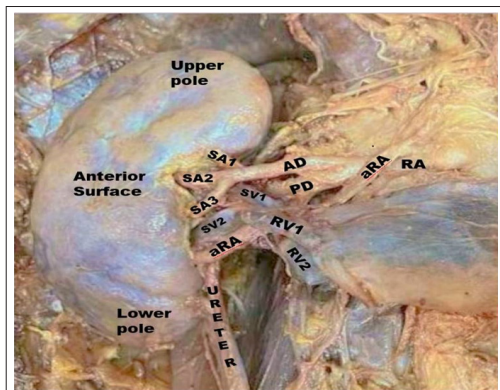


Figure 1: Anterior View - Showing Two Renal Arteries [RA & aRA] and Two Renal Veins [RV1 & RV2] for Right Kidney

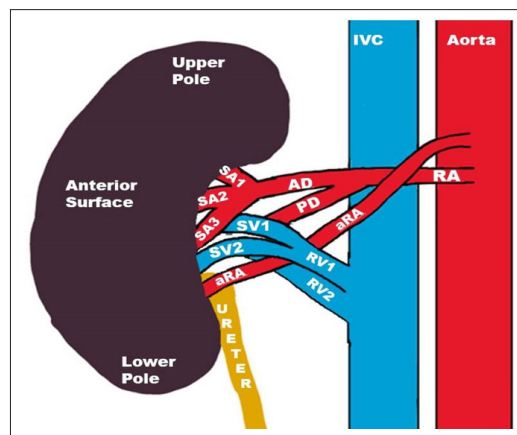


Figure 2: Schematic Presentation of Figure 1 - for Better Understanding of Readers Drawn by author Anterior View - Showing Two Renal Arteries [RA & aRA] and Two Renal Veins [RV1 & RV2] for Right Kidney

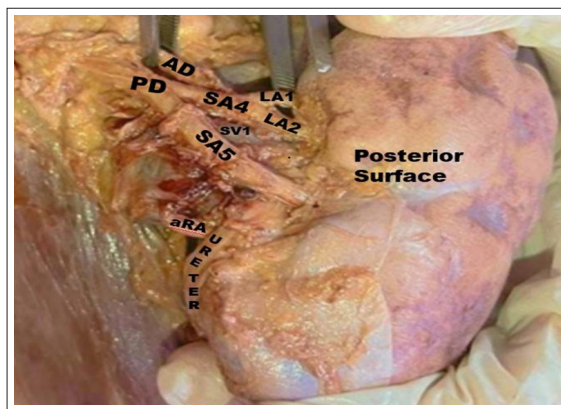


Figure 3: Posterior View – Showing Blood Vessels Supplying Right Kidney – Accessory Renal Artery and Anterior and Posterior Divisions of Main Renal Artery with further Divisions as Segmental Artery 4 & 5, Lobar Artery 1 & 2

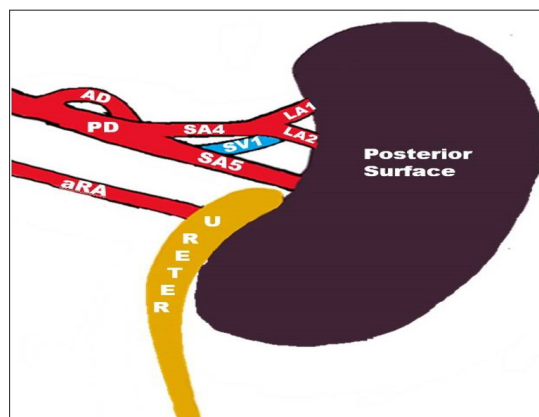


Figure 4: Schematic Presentation of Figure 3 - for Better Understanding of Readers Drawn by author Posterior View - Showing Blood Vessels Supplying Right Kidney - Accessory Renal Artery and Anterior and Posterior Divisions of Main Renal Artery with further Divisions as Segmental Artery 4 & 5, Lobar Artery 1 & 2

Discussion

In the present case there is duplication of right renal vessels. Duplication of renal veins maximum times go unnoticed and reported accidentally in renal operative procedures [13]. In review of literature the prevalence of supernumerary renal arteries is

slightly more on right side (20.2%) than on left side (19%) Prevalence rate of multiple renal vessels reported in different studies range between 20 to 40 %. Multiple renal veins are reported more on the right side [3,13,16,17].

This duplication of renal vessels can be correlated embryologically. During development, initially mesonephric arteries originating from dorsal aorta form the network of arteries which will supply to the derivatives of mesonephros, metanephros and gonads. These mesonephric arteries are normally between sixth cervical and third lumbar segments. Renal arteries arise from third to fifth pair of these arteries. In the course of development many arteries degenerate and only one mesonephric artery persists on each side as definitive renal artery which forms future renal artery. In case of lack of complete degeneration process, the remaining vessels can form multiple renal arteries giving rise to either unilateral or bilateral duplication of renal arteries [16].

Normally, renal veins develop with the contribution from supracardinal and subcardinal veins. Initially, two renal veins form one ventral and one dorsal. During further development, usually dorsal vein degenerates and the ventral vein form the definitive renal vein. Persistence of this dorsal vein may result in duplication of renal vein on right side. The accessory renal veins embryonic origin may be contributed by persistence of mesonephric veins draining into right subcardinal vein [16]. Supernumerary renal veins can be retroaortic, circumaoortic and plexiform as per its course and mode of drainage [17].

Renal vessel anomalies especially duplication or multiplication holds great significance during procedures like partial nephrectomy, vascular reconstruction in abdominal aortic aneurysm, segmental resection, renal artery stenosis, renal transplantation and renal vascular hypertension [17-19].

In renal transplantation, the duplication of veins can affect success of transplantation due to possibility of restricting mobility of renal vein [14,15]. If the graft contains multiple vessels, it can cause difficulty for the use of carrel patch from donors. This can lead to graft necrosis or segmental renal infarction sometimes post-operative hypertension and fistula formation [20]. The allografts with multiple renal arteries have a higher risk of renal artery stenosis and technical difficulties for surgeon performing transplant operation [21].

As per Dr Komali J and Hatice G, surgeons prefer single renal artery kidney over the kidney with supernumerary renal vessels when it comes to donor kidneys due to longer anastomosis time and other technical difficulties [7,10,22]. Usually acute tubular necrosis, acute & chronic graft rejection develop as a complication while using the kidneys with supernumerary renal arteries as a transplant [23,24].

Supernumerary renal arteries have low perfusion pressure and high resistance due to more length and less width. The knowledge of variations of renal angioarchitecture is also significant for management of renal trauma cases. Presence of variations may demand a transabdominal retroperitoneal approach accessing renal vessels promptly during emergency renal trauma management [20].

Author Pranav Pawar stated advantage of having supernumerary renal vessels. As per author the presence of accessory renal arteries sometimes acts as a source of alternative blood supply in cases of thrombosis of main trunk and help in maintaining osmotic fluid balance [25].

Supernumerary renal arteries secrete more renin leading to hypertension by vasoconstriction via renin angiotensin aldosterone mechanism [25,26]. 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 [26]. Fibromuscular dysplasia in supernumerary renal arteries may result into renal hypertension.

Accessory renal vessels in retroureteral position can also lead to hemorrhagic complications of endopyelotomy due to uretero pelvic junctional obstruction [19]. The aberrant renal arteries supply lower pole of kidney can lead to ureteropelvic junction obstruction [26].

Conclusion

Variations like supernumerary renal vessels are significant as kidneys are the most commonly transplanted organs. Duplications of renal vessels can affect all renal surgeries like partial nephrectomy, transplantation and has significant impact on clinical conditions like renal hypertension, ureteropelvic obstruction, acute tubular necrosis and renal stenosis.

Author Contributions

Conceptualization - KS, IRK, AB

Data acquisition - KS, IRK, AB

Data analysis or interpretation - KS, IRK, AB, MC

Drafting of the manuscript - KS, IRK, AB, MC

Critical revision of the manuscript - KS, IRK, AB, MC

Approval of the final version of the manuscript - by all author

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