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# Anomalous Renal Vessels: A Case Report

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***Abstract***

*During routine dissection, an uncommon variation was found in the renal vessels of a male adult cadaver. Right kidney was found to have three renal arteries and three renal veins with intrahilar segmental vessels whereas the left kidney has a single renal artery and a single renal vein but with pre-hilar segmental vessels i.e., outside the renal hilum. It has become imperative for the surgeons to understand the abnormalities of renal vasculature, as the utility of laparoscopic renal surgeries grew considerably. Otherwise, such surgeries may be hampered by these anatomical variations. The presence of these abnormalities is also accountable in radiological imaging, renal transplant, selective segmental clamping during partial nephrectomy. Hence, this case report may be helpful to the nephrologists, surgeons, and radiologists in dealing with the cases of renal surgeries, kidney transplantations, aneurysm of abdominal aorta, cases of trauma and hemorrhages of renal vessels.*

***Keywords:*** *Intrahilar Segmental Vessels, Kidney Transplantations, Partial Nephrectomy, and Renal Artery.*

## Introduction

The renal arteries usually arise from the lateral side of the abdominal aorta just below the origin of the superior mesenteric artery at the level of L1/L2 Intervertebral disc as a pair one to each of the kidneys. Normally the renal arteries enter the hilum of the kidney but before entering it gives a branch called inferior suprarenal artery which supplies the suprarenal gland [1]. The renal veins drain into the lateral sides of inferior vena cava just below the transpyloric plane at the level of L1/L2 Intervertebral disc on the right and left side, one from each kidney. Normally the renal veins emerge from the hilum of the kidney. The left gonadal vein drains into the left renal vein, but the right gonadal vein drains directly into the IVC (inferior vena cava).

## Case Report

During routine dissection of adult male cadaver, unlike the usual single renal artery, three arteries are directly coming from the aorta and supplying the right kidney was found. One of three is arising at the level of the L3/L4 vertebral level it runs upwards and laterally and below the right ureter till the lower pole of the right kidney and supplies the kidney named as the inferior polar artery (IPA) (Figure 1). The other two arteries are arising at the level of L2/L3 vertebral level from the abdominal aorta. These two ran laterally behind the inferior vena cava to enter the hilum of the right kidney to supply it. These are known as the Accessory renal arteries (ARA) also known as superior hilar artery (SHA) and inferior hilar artery (IHA). IHA runs towards the hilum but before

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entering the hilum, the artery divides into two segmental arteries (Figure 2, 3). IHA gives two branches inferior suprarenal artery and inferior phrenic artery. Normally, an inferior phrenic artery arises directly from the aorta but here it arises from the renal artery. Here both inferior phrenic artery and inferior suprarenal artery arises from renal artery and runs upwards, laterally and below the superior hilar artery and supplies diaphragm and adrenal gland, respectively (Figure 4).

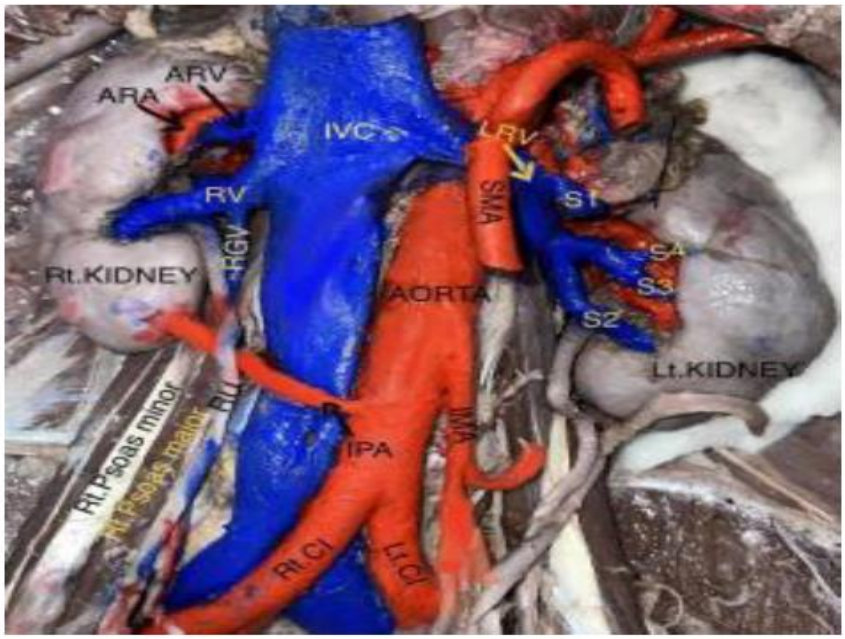


**Fig 1:** Multiple arteries and veins supplying the Right kidney and early division of the Left renal vessels. IVC=Inferior vena cava; RGV=Right gonadal vein (right testicular vein); RV=Renal vein; ARA=Accessory renal artery (superior hilar artery); ARV=Accessory renal vein; RU=Right ureter; IPA=Inferior polar artery; Rt.CI=Right common iliac; Lt.CI=Left common iliac; IMA=Inferior mesenteric artery; SMA=Superior mesenteric artery; LRV=Left renal vein; S1, S2, S3 and S4=Anterior, Lower, Middle, and Upper segmental branches respectively.

There are three renal veins arising from the medial border of right kidney at the level of L2/L3 vertebral level that drains into the IVC. Amongst these, two veins are present anterior to the hilum and run medially to drain into IVC. The other vein emerges on the posterior side of the hilum of the kidney, runs medially to drain in the posterior aspect of inferior vena cava. These are known as the accessory renal veins (ARV). The right gonadal vein (RGV) or right testicular vein here runs upwards and above the inferior polar artery and drains into the right renal vein 1cm before the renal vein drains into the IVC. This is unlike the normal RGV that drains into the inferior vena cava directly. The level at which this RGV drains into the renal vein is L2/L3 vertebral level (Figure 2, 3).


**Fig 2:** Anterior View of the Right Kidney with the Multiple Renal Vessels Rt. GV Draining Into the Renal Vein. IVC=Inferior Vena Cava. Rt. RV=Right Renal Vein; ARV=Accessory Renal Vein. Rt. RGV=Right Gonadal Vein; IPA=Inferior Polar Artery; Rt. RA=Right Renal Artery.


**Fig 3:** Posterior View of the Right Kidney Showing The Multiple Renal Vessels Supplying Kidney IPA=Inferior Polar Artery; Rt. RV=Right Renal Vein; ARV=Accessory Renal Vein; IVC=Inferior Vena Cava; ARA=Accessory Renal Artery; ISA=Inferior Suprarenal Artery; Rt. RA=Right Renal Artery; Inferior PA= Inferior Phrenic Artery; Rt. GV= Right Gonadal Vein (Right Testicular Vein); S3 & S4 = Apical and Posterior Segmental Arteries.


**Fig 4:** Superior View of the Right Kidney. IVC = Inferior Vena Cava; RRA = Right Renal Artery; ARA = Accessory Renal Artery; Rt. ISA = Right Inferior Suprarenal Artery. Inf.PA = Inferior Phrenic Artery.

In the left kidney, the left renal artery gives the three segmental branches anteriorly and one in the posterior side before entering to the hilum. These arteries are also known as the pre-hilar arteries. These are lower segmental artery, upper segmental artery, middle segmental artery. Posteriorly, the other segmental branch is known as the posterior segmental artery. The renal veins also receive the segmental branches outside the hilum. There are four segmental veins three in the anterior (upper, middle and lower segmental veins) and the other in the posterior side of hilum (posterior segmental vein). Left gonadal vein drained directly drained into left renal vein.

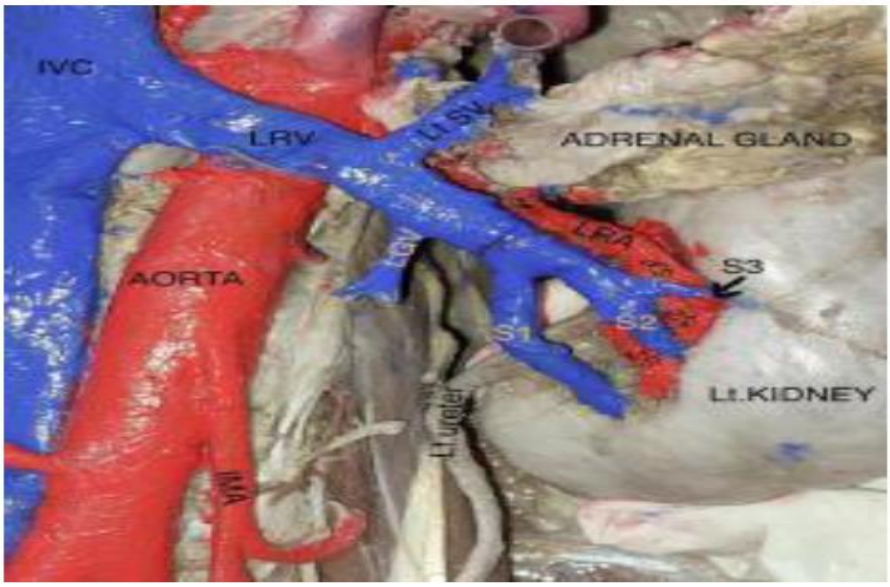


**Fig 5:** Anterior View of Left Kidney. IVC = Inferior Vena Cava; LRV = Left Renal Vein; Lt. SV = Left Suprarenal Vein; LGV = Left Gonadal Vein; LRA = Left Renal Artery; IMA = Inferior Mesenteric Artery; S1, S2 and S3 = Lower, Middle and Upper Segmental Veins; S1', S2' and S3' = Lower, Middle and Upper Segmental Arteries.

## Discussion

Renal vascular variations are extensive and present in 30% of cases [2]. Embryological development is the basis for variability in the position and source of blood supply, the branching pattern of blood vessels, the location of entry of the blood vessels into kidneys, and the relationships of the renal arteries throughout their course with adjacent structures. Most of the abnormalities of renal vessels occur because of the complex embryonic development of the kidneys. i.e., the three stages of pronephros, mesonephros and metanephros, and changing positions during ascent of the kidney from the pelvis to the lumbar region, along with its longitudinal location and simultaneous acquisition of a vascular supply. This is the reason why the possibility of anomalous development in the kidney may be greater than for other organs within the body [3].

### Embryological Basis for Accessory Renal Vessels

Kidneys develop from the intermediate mesoderm in the pelvic region and ascend to the adult position in the lumbar region. In the pelvic region, kidneys are supplied by branches of internal iliac artery or common iliac artery. With ascent, this arterial supply shifts from common/internal iliac to the abdominal aorta. The ascent stops when the kidneys come in contact with the suprarenal glands in the ninth week of intrauterine life. This relative ascent results mainly from the growth of the embryo's body caudal to the kidneys. In effect, the caudal part of the embryo grows away from the kidneys so that they progressively occupy more cranial levels. Kidneys receive their most cranial branches from the abdominal aorta during the adult position. Accessory renal arteries result from failure in the degeneration of the initial branches. Similarly, the development of the renal veins is closely related to the IVC development. The renal segment of the IVC develops from the right subcardinal vein and the subcardinal-supracardinal anastomosis. The adult human kidney is a metanephric derivative. During the development, one metanephric vein drains the right kidney into the right subcardinal vein. This vein in the future becomes the right renal vein. If there is more than one metanephric vein in fetal life, and if all of them persist, that would lead to the formation of multiple renal veins [4].

In the current case report, there were three renal arteries and three renal veins with hilar segmental vessels in the right kidney and a single renal artery and a single renal vein with pre-hilar segmental vessels in the left kidney. Embryological explanation of these variations has been presented and discussed by Felix. In an 18 mm fetus, the developing mesonephros, metanephros, suprarenal glands, and gonads are supplied by nine pairs of lateral mesonephric arteries arising from the dorsal aorta. Felix divided these arteries into three groups as follows: the 1st and 2nd arteries as the cranial, the 3rd to 5th arteries as the middle, and the 6th to 9th arteries as the caudal group. The middle group gives rise to the renal arteries. The persistence of more than one artery of the middle group results in multiple renal arteries [5]. Thus, the multiple renal arteries in our study are a result of persisting lateral mesonephric arteries from the middle group. Also, as these arteries are segmental and supply certain vascular area within the kidney and since they are end-arteries, the terminology “supernumerary” can be used for these arteries and can be classified in accordance with Merklin and Michels as supernumerary renal arteries originating from the aorta for the right kidney and supernumerary renal arteries originating from main renal arteries for the left kidney [6, 7].

### Embryological Basis for Right Gonadal Vein Draining into Right Renal Vein

The variation of the gonadal vein in the present study can also be understood on embryological basis. Development of the gonadal vein occurs from the caudal part of the

subcardinal vein. Gonadal vein drains into supracardinal and subcardinal anastomosis. The portion of the IVC which receives the right gonadal vein is developed from an anastomosis between the right supracardinal vein and the right subcardinal vein. The anastomosis of the supracardinal vein and the subcardinal vein on the left side contributes to the development of the left renal vein. In the present case, the renal vein is formed by anastomosis between the right supracardinal vein and right subcardinal vein, hence receives the right testicular vein [8].

### Clinical Implications of Accessory Renal Arteries

Accessory renal arteries are "essential" vessels of the kidney. Even though they are called additional/accessory arteries, they are not to be considered optional, since blockage in any accessory artery compromises the kidney functionally in the same way as blockage of the main renal artery. The presence of ARAs increases the challenge and complexity of diagnostic and surgical procedures. Accessory renal arteries could be the cause of hypertension when they undergo stenosis due to hilar congestion. They may cause problems during renal transplant surgeries. Pre-operative renal embolization is one of the safe techniques to minimize bleeding during laparoscopic nephrectomies. However, when the accessory renal arteries are present, there could be unexpected bleeding [9]. The knowledge about accessory renal arteries has its importance during transplantation; failure to anastomosis with a suitable graft may lead to segmental kidney necrosis [10]. The presence of accessory renal arteries can also impair renal function and enhance atherosclerotic plaque formation if it is close to the aortic bifurcation [11].

## Conclusion

Anatomical variation in the renal vascular system has significant clinical implications in endoscopic surgeries, radio diagnostic procedures and renal vascular interventions such as those required during transplantation surgery. Knowledge of the anatomical variations in renal vessels is especially important to urologists, radiologists, and vascular surgeons as they encounter these situations during segmental resection, partial nephrectomy, and renal transplantation. This knowledge and prior identification of the multiple renal vessels helps the surgeon to explore and treat renal trauma, renal transplantation, angioplasty, and radical renal surgeries to prevent complications.

## Conflict of Interest

The authors declare that there are no conflicts of interest related to this study.

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