

A Study of Embryological Basis of Variations of Renal Vessels

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Abstract

Kidneys are supplied by a pair of renal arteries which arise from abdominal aorta and branches laterally below the superior mesenteric artery. A single renal artery arising from aorta supplying the corresponding kidney is actually seen in less than 25% of cases. Kidneys are drained by pair renal veins into inferior vena cava. Variations in the number and branching pattern of renal vessels are common. Persistence of lateral splanchnic arteries is the main reason for variation in the number of renal arteries. The different fate of right and left subcardinal and supracardinal anastomosis is responsible for the presence of supernumerary renal veins. *Aims and objectives:* To study the anomalous pattern of renal vessels and its clinical implications. *Materials and methods:* We studied 100 cadavers over a period of 3 years for the presence of anomalies of renal vessels. *Results:* We found 3 cases of double renal arteries all on left side; 2 cases of double renal veins on right side; 1 case of pre-hilar division of renal artery. We also found 2 unusual variations: in the 1st case, inferior phrenic artery arose from right renal artery; in the 2nd case testicular artery arose from left renal artery. *Conclusion:* Variations in renal vessels can go unnoticed many times and can give rise to a number of clinical manifestations. A thorough knowledge of renal vessels is thus important for radiologic, diagnostic, operative and endovascular procedures.

Keywords: Renal Artery; Renal Vein; Lateral Splanchnic Artery; Abdominal Aorta; Inferior Vena Cava.

Introduction

Kidneys are supplied by a pair of renal arteries which arise from aorta and passes laterally below the superior mesenteric artery at the level of L₁. Right renal artery is longer and higher than the left. Usually each kidney is supplied by 1 renal artery which divides into 5 segmental branches close to the hilum [1]. Different nomenclatures have been used to describe additional renal arteries as aberrant, supernumerary, multiple, accessory, etc. According to Graves, any artery arising from aorta supplying

the kidney in addition to main renal artery should be named as 'accessory' renal artery. An artery arising from other source apart from aorta is labeled as 'aberrant' renal artery [2].

Kidneys are drained by a pair of renal veins into IVC. The left renal vein is generally longer of the 2 because IVC is situated on the right side of the body [1]. The right renal vein rarely receives tributaries, whereas left renal vein regularly has complex connections with other venous channels and usually receives left gonadal vein, left suprarenal vein and left inferior phrenic vein.

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Embryological Basis [3, 4]

Variations of renal and gonadal vessels have an embryological basis. According to Felix, nine pairs of lateral splanchnic arteries arising from the dorsal aorta are divided into 3 groups viz: the cranial, middle and caudal group which supply developing mesonephros, metanephros, suprarenal glands and gonads. The middle group gives rise to the renal arteries. The variation in the number of renal arteries

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is because of persistence of more than 1 artery of the middle group [3] or due to persistence of blood supply from lower level than normal [4]. Gonadal arteries can arise from any of these 9 splanchnic arteries though they usually arise from the caudal group [5]. In the present case, the origin of the left testicular artery from lower renal artery suggests the embryologic origin of this vessel from the middle group.

During development of inferior vena cava, a circum aortic venous ring, the "renal collar" is formed which is contributed mainly by subcardinal veins, inter subcardinal anastomosis, supracardinal veins and inter supracardinal anastomosis [6]. The different fate of right and left subcardinal and supracardinal anastomosis is responsible for the presence of supernumerary renal veins. On the right side, the anastomosis between subcardinal and supracardinal veins is incorporated in the development of IVC which may be the reason for persistence of primitive veins resulting in multiple veins on that side, while on the left side, the anastomosis between subcardinal and supracardinal veins completely disappears.

Materials and Methods

We studied 100 cadavers over a period of 3 years for the presence of anomalies of renal vessels.

Case 1: In a 55 years male cadaver, on the left side, the kidney was supplied by 2 renal arteries. The upper renal artery (URA) was larger than the lower. Both arteries were arising from the aorta; the gap between the 2 being 0.3 mm. The upper renal artery divided into segmental branches. The lower renal artery (LRA) entered into the kidney without dividing into segmental branches. In addition the lower renal artery gave off left testicular artery which is unusually torturous in its course. The left testicular vein drained into left renal vein.

Case 2, 3 & 4: Accessory renal arteries were found in 3 more cases (1.5%) all on left side.

In 1 male cadaver aged 60 years we got 2 renal arteries arising from the aorta on the left side with a gap of 0.2 mm. The upper renal artery entered into the kidney without dividing into segmental branches. The lower renal artery entered into the kidney by

dividing into segmental branches (double RA2).

In a male cadaver aged 45 years, we found 2 renal arteries arising from the aorta: 1 was arising above the level of left renal vein and the other was arising below it with a gap of 1.2 cm (DRA 1a).

In another male cadaver, the left kidney was supplied by 2 renal arteries. Both arteries were arising from the aorta; the gap between them being 0.3 mm. (Doublera).

Case 5: While dissecting a middle aged male cadaver, we got inferior phrenic artery arising from right renal artery and it was unusually torturous in its course. It also gave a branch to the suprarenal gland.

Case 6: The renal artery usually divides into 5 segmental branches close to the hilum of the kidney. In this case, we got pre-hilar division right of renal artery.

Variations were Found in Renal Veins Also

Case 7: The presence of an additional renal vein draining directly into IVC was found on the right side during routine dissection of a middle-aged male cadaver. Both the renal veins were lying anterior to the renal artery and ureter. The upper vein was larger than the lower vein. The two veins were coming out from the upper and lower ends of the hilum and opened into IVC (DRV 4).

Case 8: We got 1 more case of double renal veins having a normal course, lying anterior the renal artery and ureter, on the right side draining into inferior vena cava. Both upper and lower renal veins had a normal caliber.

Results

200 specimens of human kidneys from 100 cadavers were dissected carefully and following results were found.

1. Accessory renal arteries were found in 3 cases (1.5%) all on left side.
2. Division of renal artery close to the aorta (pre-hilar division) was found in 1 case (0.5%).

Sl. No.	Renal vessel	Variations found	Left kidney	Right kidney
1.	Renal artery	Accessory renal artery arising from aorta	3 (1.5%)	0
		Prehilar division of renal artery	0	1
		Inferior phrenic artery arising from renal artery	0	1
		Testicular artery arising from renal artery	1	0
2	Renal vein	Double renal veins draining into IVC	0	2 (1%)

3. Two cases of double renal veins were seen on right side (1%).
4. Inferior phrenic artery arising from right renal artery was found in 1 case (0.5%).
5. Testicular artery arising from left renal artery was found in 1 case.

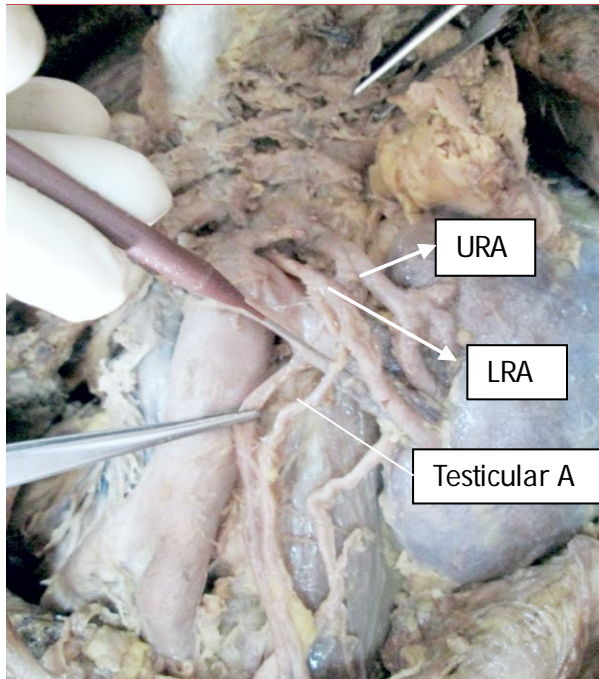


Fig. 1: Double renal arteries on left side Left testicular A arising from lower renal artery

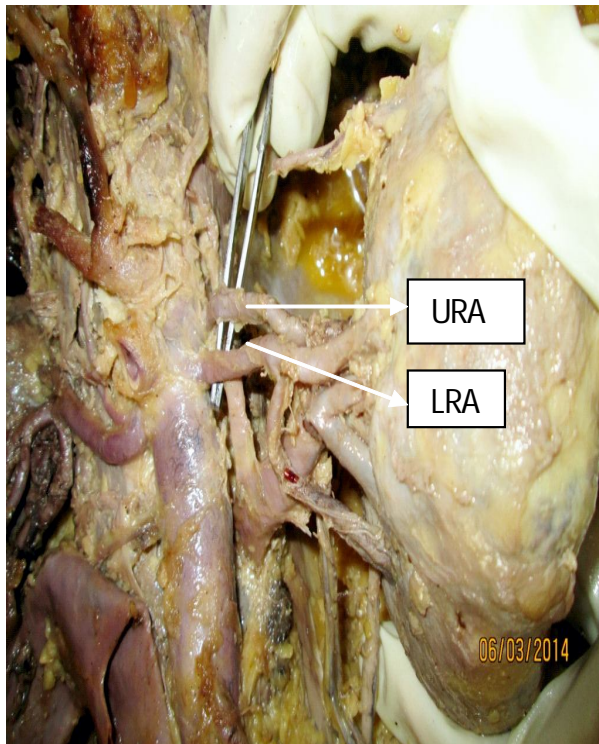


Fig. 2: Double renal arteries on left side

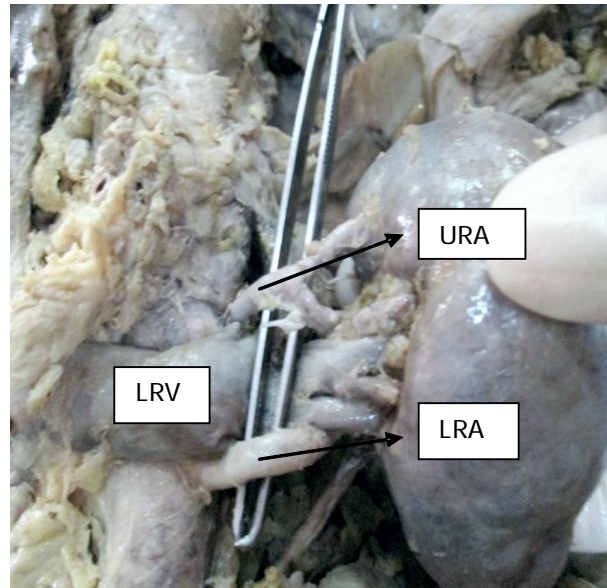


Fig 3: Double renal arteries on left side

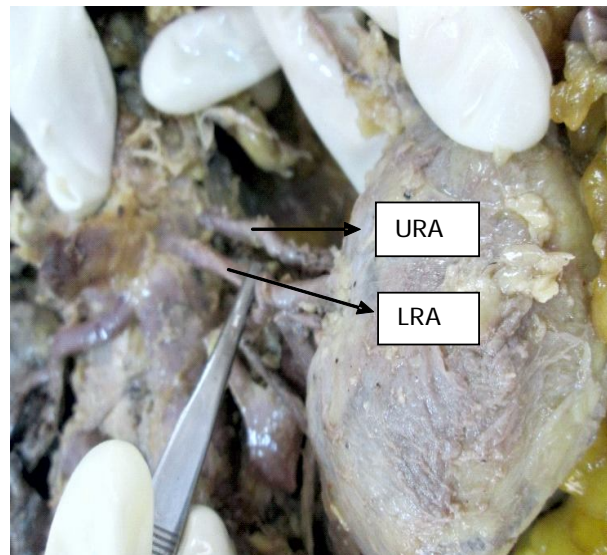


Fig. 4: Double renal arteries on left side

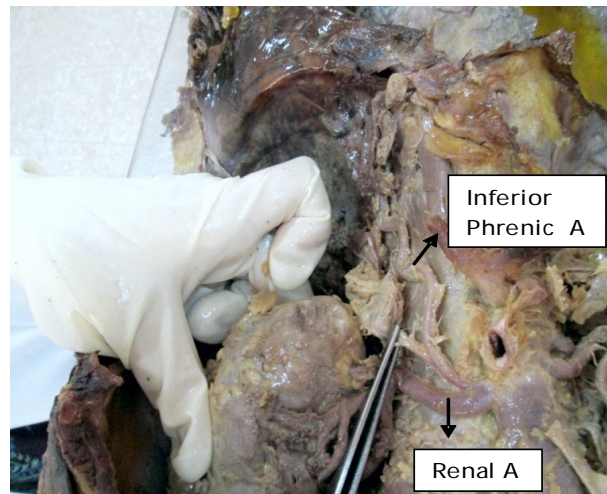


Fig. 5: Inferior phrenic A arising from right renal A

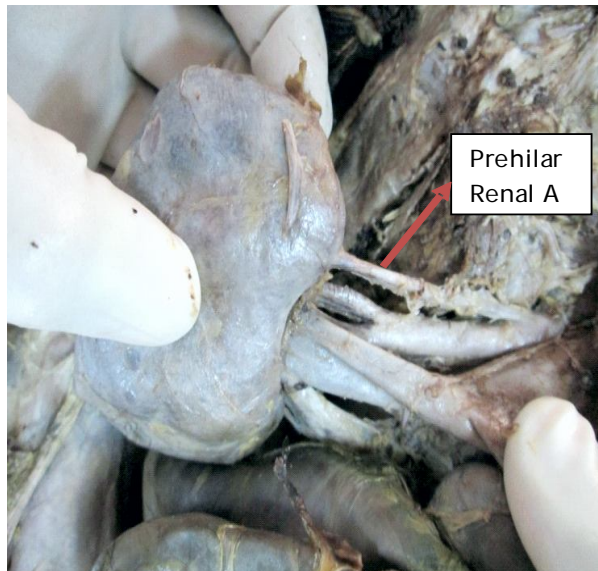


Fig. 6: Prehilar division of Renal A

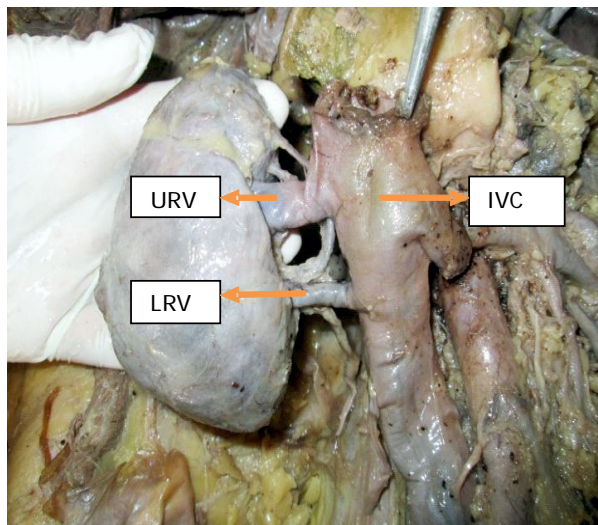


Fig. 7: Double renal veins on right side

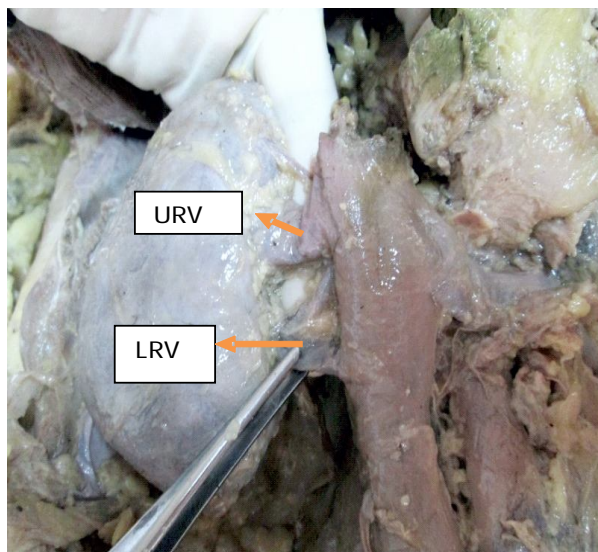


Fig. 8: Double renal veins on right side

Discussion

The permanent kidney or metanephros develops between the sixth and ninth week of intrauterine life within the pelvis and ascends to the lumbar level following a path on either side of the dorsal aorta. The ascending kidney is progressively revascularised by a series of arterial sprouts from the dorsal aorta, and the arteries at lower levels gradually regress. Occasionally one or more of the transient renal arteries at lower levels fail to regress resulting in the presence of accessory renal arteries. Thus accessory arteries are normal segmental arteries with more proximal origin than usual [4]. Previous studies have shown the origin of accessory renal arteries from aorta and the renal artery [7, 8]. In this study all the accessory arteries were arising from the abdominal aorta. Variations regarding the side on which the additional renal arteries were seen was also reported. Some authors have reported a higher frequency on the left [9], whereas others have found it to be more frequent on the right side [10]. In the present study, all accessory renal arteries were found on left side.

Presence of additional renal vein has been reported to occur in 14% cases [11]. According to Satyapal there is 10 fold increase in the number of additional renal vein on the right side as compared to the left side. Satayapal also reported that incidence of additional right renal vein was 26% as compared to 2.6% on the left side [12], while Pick & Anson reported 27.8% additional veins on right side [13]. Pollak et al also observed that additional renal veins and other venous variations are more common on the right side [14]. In the present study also the same observation were seen. Additional renal vein may act as an alternate collateral route if the inferior vena cava has been interrupted between these veins [15].

We have come across an anomalous origin of right testicular artery from right accessory renal artery. Testicular arteries are paired vessels that usually arise from the antero-lateral surface of the abdominal aorta at the level of L2 (1). 4.7-14% of gonadal arteries arise from the renal arteries as reported by Asala et al., In their study of 150 cadavers, Asala et al found testicular arterial variations only on the right side (4.7%). In 4 (2.6%) of these cases, testicular arteries branched from the renal artery [16].

Conclusion

Though aberrant renal vasculature may remain undiagnosed throughout life, they could give a

formidable challenge during aortic reconstruction surgery for aorto-femoral aneurysms and post-renal aortic aneurysms. Therefore pre-operative radiological imaging is required to know the uncertain anatomy of aberrant renal vessels to minimize the risk of peri operative and post operative haemorrhage.

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