ANATOMICAL VARIATIONS OF RENAL ARTERY AND ITS SURGICAL CORRELATIONS: A CADAVERIC STUDY

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ABSTRACT

BACKGROUND

Kidneys are retroperitoneal organs normally supplied by the paired renal arteries. Each kidney is supplied by a single renal artery which arises as a lateral branch of abdominal aorta, between the levels of L1 and L2. Morphological variations of renal artery include variations in their number and unusual branches. Most of these variations remained unknown until being discovered during any surgical procedure or found during autopsy. We wanted to determine prevalence of multiple renal arteries in Kolhapur population and to provide their surgical correlation.

METHODS

Formalin embalmed 50 cadavers constituted the material for study. During routine abdominal dissection conducted for medical undergraduates in the Department of Anatomy, kidneys along with their arteries were explored and the morphological variations of renal arteries were noted.

RESULTS

We observed multiple renal artery variations in 32 cadavers including duplicate renal arteries, triplicate renal arteries, prehilar multiple branching, superior polar and inferior polar artery.

CONCLUSIONS

Awareness of variations of renal artery is necessary for surgical management during renal transplantation, repair of abdominal aorta aneurysm, urological procedures and for angiographic interventions.

KEYWORDS

Renal Artery, Superior Polar Artery, Inferior Polar Artery, Abdominal Aorta.

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BACKGROUND

Classically, a single renal artery supplies each kidney, which is the direct branch of abdominal aorta. According to Grey's anatomy,[1] the large renal artery branch laterally from the aorta just below the superior mesenteric artery. Each kidney is supplied by a single renal artery in approximately 70% of individuals. The level of origin and course of renal arteries and their precise relations are variable. Near the renal hilum, each artery divides into an anterior and a posterior division, and the anterior division divides into apical, anterior upper, anterior middle and lower segmental arteries supplying the renal segments.

In 30% of individuals most common variation are accessory renal arteries which 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. Among many studies, in one study accessory renal arteries were observed in 20% of the specimens by Dhar and Lal[2] and many variations found by others. However, renal artery variations are very common.

Variations regarding their origin and number have been reported by many researchers.[3-5] Awareness of the possible variations of the renal arteries is necessary for the invasive interventions such as renal transplantation, interventional radiologic procedures and urologic operations.[6,7]

METHODS

The formalin embalmed 50 cadavers (40–75 years old) in R.C.S.M.G. Medical College, Kolhapur, Maharashtra constituted the material for study. The cadavers were donated by relatives with consent letter and death certificate. None of them had any pathological lesions, traumatic lesions or surgical procedures in the abdominal region. During routine abdominal dissection conducted for medical undergraduates as per Cunningham's Manual of Practical Anatomy Volume -2 (Thorax and abdomen) the right and left kidneys and the surrounding tissues were removed en bloc with the adjacent part of the aorta cleared and studied.[8] Kidneys along with their arteries were explored and the morphological variations of renal arteries were noted.

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RESULTS

Type of Variations	Number of Cases	Right Kidney	Left Kidney
Prehilar multiple branching	13	7 (53.84%)	6 (46.15%)
Duplicate renal artery	7	5 (71.42%)	2 (28.57%)
Triplicate renal artery	2	1 (50%)	1 (50%)
Superior polar artery	9	6 (66.66%)	3 (33.33%)
Inferior polar artery	1	✓	1 (100%)

Table 1. Renal Artery Variations & Frequency Distribution

100 specimens of human kidneys from 50 cadavers were dissected carefully and following results were found.

1. Prehilar multiple branching were observed in 13% (Table 1, Figures 1, 2, 4).
2. Duplicate renal artery were noted in 7% specimens and 2% specimens showed triplicate renal artery (Table 1, Figure 1).
3. Superior polar artery and inferior polar artery were observed in 9% and 1% specimens respectively (Table 1, Figure 1 & 3).
4. An accessory renal artery arising from the aorta entering to the lower pole without passing through the hilum in one specimen (Figure 3).
5. An accessory renal artery arising from the aorta entering to the upper pole without passing through the hilum in three specimens (Figure 1).

DISCUSSION

Variations in renal arteries are not uncommon. Shoja MM et al. (2008) studied the perihilar branching pattern of renal artery. They observed fork pattern in 92.6% kidneys, duplicate in 80.2%, triplicate in 12.4% and ladder pattern in 7.4% kidneys.[9] Prehilar multiple branching of renal arteries were reported by Rao M et al (2006). Virendra Budhiraja, Rakhi Rastogi, A. K. Asthana studied prehilar multiple branching of renal arteries in 11 (11.66%) cases. These branches were directed towards apical, superior, middle, inferior and posterior vascular segment of kidney. They also observed duplication of renal arteries in eight (8.33%) cases. On right side, they were observed in five out of eight cases (62.5%) and three out of eight cases (37.5%) on left side, so the frequency was more on right side.[10]

In our study we observed 32(32%) kidneys out of 100 kidneys had additional arteries. Prehilar multiple branching were observed in 13 specimens in which 7 (53.84%) on the right side and 6 (46.15%) on the left side. Duplicate renal artery were noted in 7 specimens out of which 5 (71.42%) on the right side & 2(28.57%) on the left side. We also found 2 specimens of triplicate renal artery one on either side (1(50%)). Superior polar artery was found in 9 specimens in which 6(66.66%) on the right side and 3(33.33%) on the left side. While only one specimen of left side showed inferior polar artery arising from the aorta entering to the lower pole without passing through the hilum.

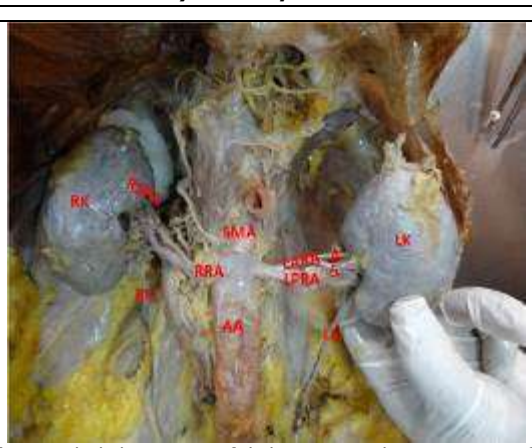
As multiple branches of renal artery correspond to segmental branches, the risk of haemorrhage during renal transplantation, segmental ischemia and postoperative hypertension due to loss of parenchyma increases.[7]

There are reports of duplication of renal arteries.[11,12] Bordei P et al. (2004) studied renal vascularization and reported 54 cases of double renal arteries supplying one kidney and originating from aorta. Of the 54 cases, six cases were bilateral. In about 28 cases, supplementary renal artery entered the kidney through the hilum, in 16 cases it was inferior polar, in five cases it was superior polar.[6]

Incidence of multiple arteries has been reported to be 20.2% and 19% on right and left sides, respectively by Janschek EC et al. in 2004,[13] however Saldarriaga B et al. (2008) reported ninety-seven (24.9%) out of 390 kidneys having additional arteries; 87 (22.3%) had one additional artery and 10 (2.6%) had two additional arteries. The frequency of one additional artery was 43.5% on right side and 56.3% on left side.[14] There was discrepancy regarding the side the additional arteries were presented; some authors have reported a higher frequency on the left side,[5,15] others reported this variation to be more frequent on the right side.[16-19]

[RK- Right kidney, **LK-** Left kidney, **RU**-Right ureter, **LU**-Left ureter, **AA** –Abdominal aorta, **SMA-** Superior mesenteric artery, **RARA-** Right anterior renal artery, **RPRA-** Right posterior renal artery, **LARA-** Left anterior renal artery, **LPRA-** Left posterior renal artery, **LARA**- Left accessory renal artery**]**

Figure 1. Right Kidney with Duplicate Renal Arteries and Left Kidney with Triplicate Renal Arteries



[RK- Right kidney, **LK-** Left kidney, **RU**-Right ureter, **LU**-Left ureter, **AA** –Abdominal aorta, **SMA-** Superior mesenteric artery**,** **RRA**- Right renal artery, **RSPA**- Right superior polar artery, **LARA-** Left anterior renal artery, **LPRA-** Left posterior renal artery, **A-** Apical segmental branch, **S-** Superior segmental branch**]**

Figure 2. Right Kidney with Right Superior Polar Artery & Prehilar Branching

[RK- Right kidney, **LK-** Left kidney, **RU**-Right ureter, **LU**-Left ureter, **AA** –Abdominal aorta, **SMA-** Superior mesenteric artery, **IVC**- Inferior vena cava, **RRA**- Right renal artery, **LRA**- Left renal artery, **LIPA-** Left inferior polar artery, **A-** Apical segmental branch, **S-** Superior segmental branch, **M-** Middle segmental branch, **I**- Inferior segmental branch**]**

Figure 3. Left Kidney with Left Inferior Polar Artery

[RK- Right kidney, **LK-** Left kidney, **RU**-Right ureter, **LU**- Left ureter, **AA**- Abdominal aorta, **SMA**- Superior Mesenteric Artery, **IVC**- Inferior vena cava, **RRV**- Right renal vein, **LRV**- Left renal vein, **RRA**- Right renal artery, **RSPA**- Right superior polar artery, **P**- Posterior segmental branch, **LRA**- Left renal artery, **LARA**- Left anterior renal artery, **LPRA**- Left posterior renal artery]

Figure 4. Right Kidney with Right Superior Polar Artery

CONCLUSIONS

This study found large number of renal artery variations which is critical for renal angiography, urological procedures, renal transplantations and surgical approach of kidney.

To plan adequate surgical procedure and to avoid unintentional vascular complications, preoperative renal imaging is necessary.

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