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Research Article

VARIANT ORIGIN OF RENAL ARTERIES AND ITS CLINICAL IMPLICATION

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ABSTRACT
The paired renal arteries arise from the aorta just below the origin of the superior mesenteric artery and takes 20% of cardiac output. These are end arteries with no anastomoses. Variations in the number and arrangement of the renal vessels are extremely common. In the present study out of 80kidneys 40(50%) kidneys showed the presence of additional renal arteries. The results are statistically significant. The presence of additional renal arteries was found unilaterally in 14 cadavers and bilaterally in 6 cadavers. In 10 kidneys additional artery towards the superior pole (Superior polar artery) was observed and in 10 kidneys inferior polar arteries were seen. And superior and inferior polar arteries both are present in 20 kidney specimens. In 40 kidney specimens we were found duplicated renal arteries. With the increase in number of cases of kidney transplantation, living donor grafts have become major source for maintaining the donor pool, and the successful allograft with multiple arteries had become a necessity. Variations in the origin and course of the renal arteries occur frequently and are of special interest to the urologist with respect to the disease associated with it. Multi Detector Computer Tomography (MDCT), angiography and arteriography should be performed prior to every nephrectomy. It become's mandatory for the surgeon to understand the abnormality or variations in the renal vasculature.

Key Words: *Abdominal Aorta, Duplicated Renal Artery, Inferior Polar Artery, Kidney, Superior Polar Artery*

Abbreviations
SPA: superior polar artery, IPA: inferior polar artery, AA: abdominal aorta, SMA: superior mesenteric artery, IVC: inferior vena cava, S: segmental artery, RT: right, LT: left, RA: renal artery, RV: renal vein

INTRODUCTION
The paired renal arteries arise from the aorta just below the origin of the superior mesenteric artery and takes 20% of cardiac output. These are end arteries with no anastomosis. Near the hilum of the kidney, each renal artery divides into anterior and posterior branch, which in turn divides into a number of segmental arteries supplying the different renal segments.
Classically, a single renal artery supplies each kidney. Variations in the number and arrangement of the renal vessels are extremely common. The so called aberrant or accessory arteries were in fact, normal segmental arteries. As the invasive interventions such as renal transplantation, interventional radiologic procedures and urologic operations increase, awareness of the possible variations of the renal arteries is necessary for adequate surgical management in the aforementioned specialties. Knowledge of the variations of renal vascular anatomy has importance in exploration and treatment of renal trauma, renal transplantation, renovascular hypertension, renal artery embolization, angioplasty or vascular reconstruction for congenital and acquired lesions, surgery for abdominal aortic aneurysm and conservative or radical renal surgery.
The advent of more conservative methods in renal surgery has necessitated a more precise knowledge of renal vascularisation and its importance in partial and total renal transplantation surgeries. Riches, Abehouse and Lerman advised renal angiography prior to all the urological surgeries. In the present study, we observed the variation in the numbers and source of origin of renal artery.

MATERIALS AND METHODS

A total 40 formalin (38%) fixed cadavers irrespective of sex of cadavers constituted the material for the study. During routine abdominal dissection conducted for medical undergraduates of one of the government medical college, Gujarat. The kidneys and their arteries were explored and variations in morphological patterns of renal arteries were noted. During the course of dissection, various abdominal viscera were removed and preserved as specimens for teaching purposes. Renal veins were also reflected for proper visualization of segmental patterns of renal arteries.

RESULTS AND DISCUSSION

Out of 40 formalin fixed cadavers, we found anomalies of renal arteries in 20(50%) cadavers. In which bilateral variations were found in 6 cadavers and unilateral variations were found in 14 cadavers. Out of 80 kidney specimens in 10(12.5%) kidneys we observed superior polar artery (figure 1 & 3), in 10(12.5%) kidney specimens inferior polar artery (figure 1 & 2) and in 40(50%) kidney specimens duplicated renal artery (figure 4). in 20(25%) kidney specimens superior and inferior polar arteries both were present (figure 1). All the superior polar arteries were arising from the abdominal aorta at the level of superior mesenteric artery. Before entering into the upper pole it gives 2-3 segmental arteries. All inferior polar arteries were arising from the abdominal aorta except in one kidney specimen it was arising from the renal artery where it crosses anterior to the renal artery and enters into lower pole after dividing into segmental arteries. Duplicated renal arteries arising from the abdominal aorta 2 cm below the superior mesenteric artery and before entering into the hilum it divides into 2-3 prehilar segmental arteries. In two kidney specimens we found polycystic changes with changes in arrangement of hilar structures (renal artery, renal vein and pelvis of ureter before backwards).

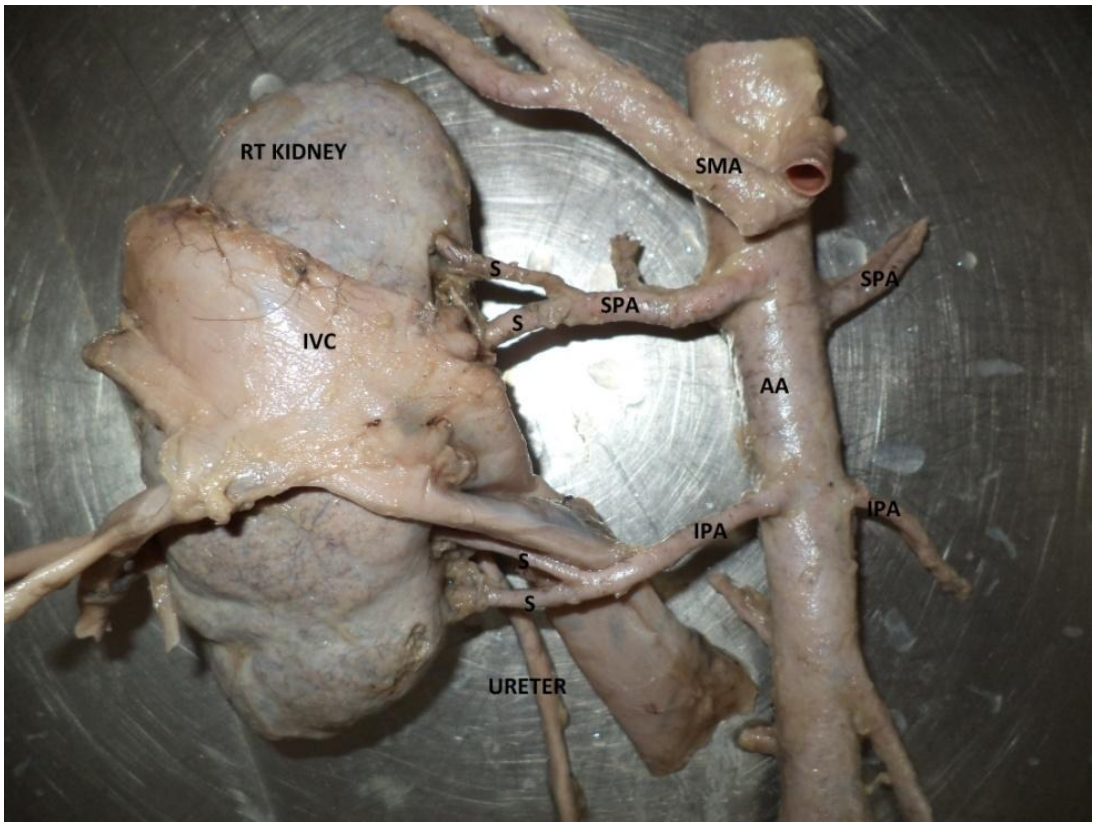

Figure 1: Right Kidney (SPA: superior polar artery, IPA: inferior polar artery, AA: abdominal aorta, SMA: superior mesenteric artery, IVC: inferior vena cava, S: segmental artery, RT: right)

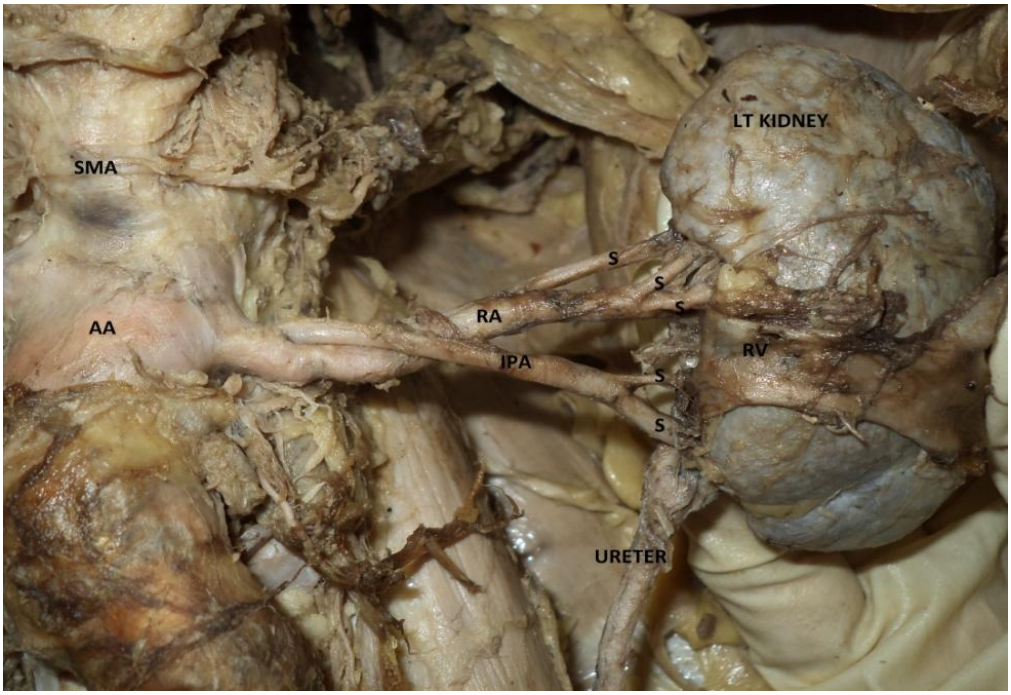

Figure 2: Left Kidney (IPA: inferior polar artery, AA: abdominal aorta, SMA: superior mesenteric artery, IVC: inferior vena cava, S: segmental artery, LT: left, RA: renal artery, RV: renal vein)

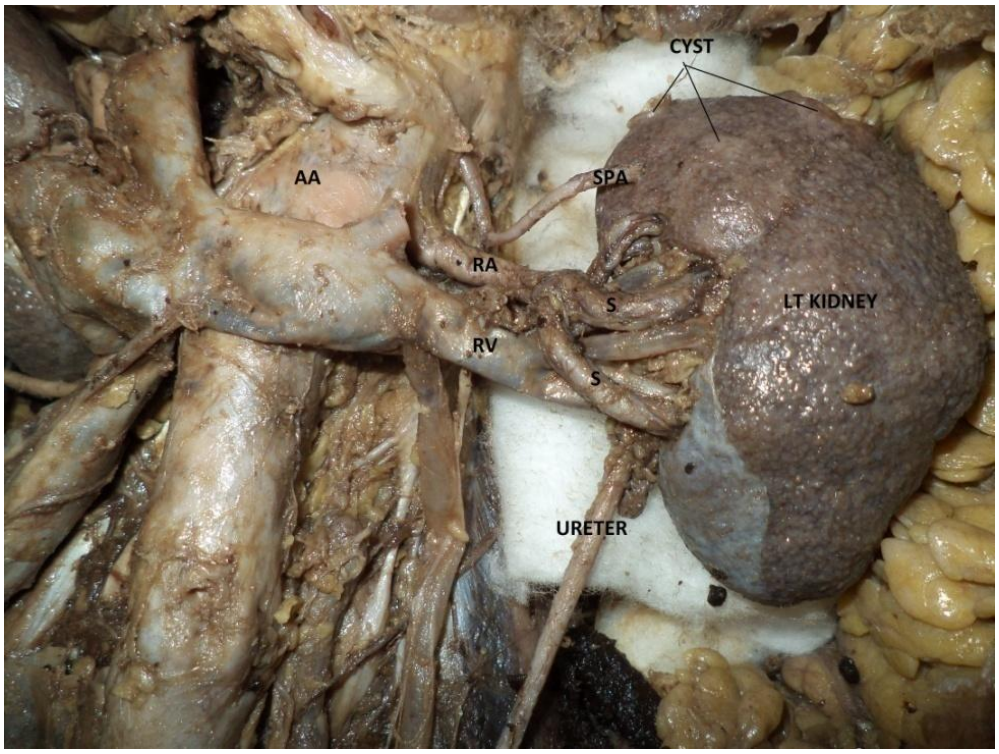

Figure 3: Left Kidney ((SPA: superior polar artery, AA: abdominal aorta, SMA: superior mesenteric artery, IVC: inferior vena cava, S: segmental artery, LT: left, RA: renal artery, RV: renal vein)

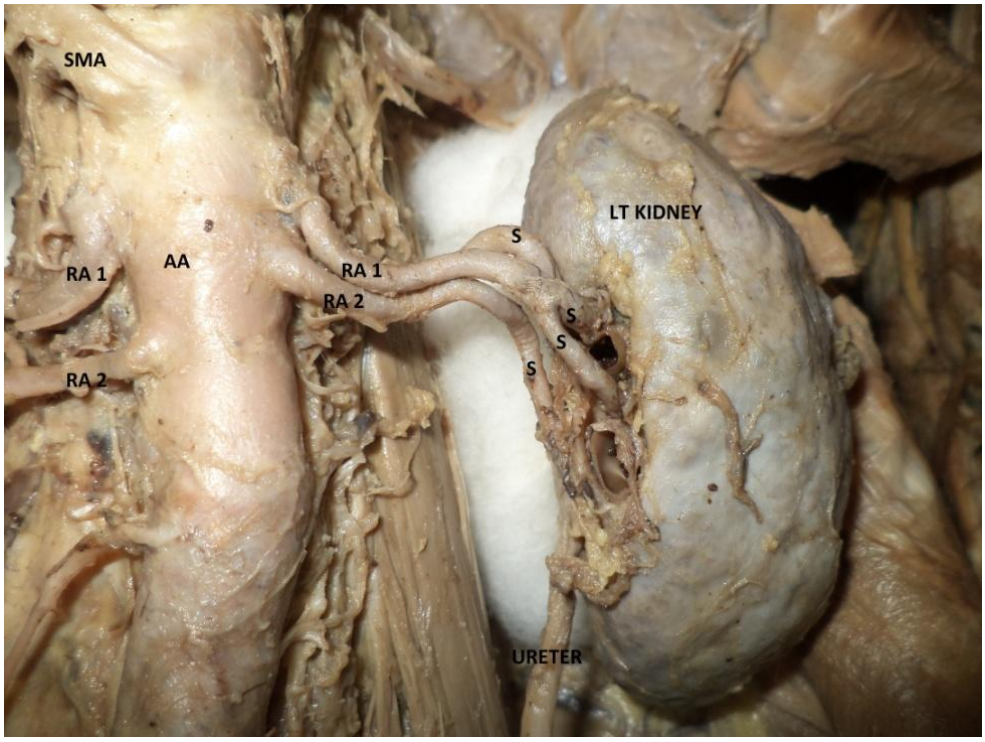

Figure 4: Left Kidney ((IPA: inferior polar artery, AA: abdominal aorta, SMA: superior mesenteric artery, S: segmental artery, LT: left, RA: renal artery)

Renal artery variations including their number, source and course are very common. Irregularities the most common being an additional or accessory artery arising above or below the usual renal artery and entering in to upper pole or lower pole named as superior and inferior polar artery respectively. And the artery other than the main renal artery was entering in to the hilum named as a duplicated renal artery. During development, the kidneys initially lie in the pelvic cavity. As the embryo grows they ascend to reach the lumbar region. When they are present in the pelvic cavity, they take their blood supplies from branches of iliac arteries, and as they ascend their blood supplies also shift from the iliac arteries to the abdominal aorta. The presence of abnormal number, site and accessory (superior polar & inferior polar artery) arteries are due to the persistence of embryonic vessels which are formed during the ascent of the kidneys (Hamilton *et al*., 1979). In our opinion it is essential for surgeons to bear in mind the possibility of such additional superior polar arteries before performing any transplantation surgeries, as kidney transplantation with multiple renal arteries has a chance of rejection, tubular necrosis, or poor graft function (Brannen *et al.,* 1982; Gupta *et al.,* 2010; Harrison *et al.,* 1978). Sampaio *et al.,* 1992 observed superior polar artery origin from the aorta in 6.8% of kidneys. Bordei *et al.,* 2007 reported that in 5 out of 54 cases (9.25%) the supplementary renal artery entered the kidney through the superior pole.Budhiraja *et al.,* 2008 observed that 10.7% of cases the superior polar artery originated directly from the abdominal aorta as an additional renal artery. A branch originating directly from the renal artery (superior renal polar branch) was observed on the right hand side in 26 kidneys (17.2%) and in 19 on the left-hand side (13.5%) (Saldarriaga *et al.,* 2008*)*.

In present study (figure 1 & 3) out of 80 kidney specimens in 10(12.5%) kidneys we observed superior polar artery which is the branch of abdominal aorta. Our data is slightly higher than the above mentioned data.

The right-hand inferior renal polar branch was observed in 5 specimens (3.3%) and 5 on the left-hand side (3.5%). Inferior renal polar arteries are usually single and arise from the aorta (95.5% of cases), or the renal artery (1.4% of cases). They have also been reported arising from a suprarenal, common iliac or

superior mesenteric artery. They may have a high aortic origin, and hence may cross the lower renal arteries to supply the inferior pole of the kidney. The inferior polar arteries are sometimes doubled, with one arising from the aorta and the other from the renal, or the pair from either source. They may or may not be accompanied by a vein .7 cases (3.5 per cent) an aberrant inferior polar renal artery, curving around the renal vein, was present in addition to the normal renal artery. Six of these were on the left side and 1 on the right. The vessel originated from the aorta below the level of the corresponding renal vein (Hilel Nathan *et al.*, 1958; Janschek *et al.*, 2004) was found inferior polar artery in 16 cases.

In present study out of 80 kidney specimens 10(12.5%) kidney specimens inferior polar artery was arising from the abdominal aorta (figure 1) and in one case it was arising from the renal artery (figure 2).

Duplicated renal arteries were observed on both sides. On right side, they were observed in five out of eight cases (62.5%) and on left side three out of eight cases (37.5%).They were found running as anterior and posterior renal arteries as well as accessory renal arteries (Virendra Budhiraja *et al.*, 2010). Bordei *et al.*, (2004) studied renal vascularisation 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. Incidence of multiple arteries has been reported to be 20.2% and 19% on right and left sides, respectively by Janschek *et al.*, 2004. However Saldarriaga *et al.*, (2008) reported 97(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.

In present study (figure 4) out of 80 kidney specimens in 40(50%) kidney specimens duplicated renal artery was arising from the abdominal aorta. It is suggestive of higher incidence of presence of double renal arteries.

Conclusion

Here in the present study we observed the presence of superior and inferior renal polar artery in 12.5% of cases respectively and both were present simultaneously in 25% of cases. In most of the cases they were arising from the abdominal aorta except in one case inferior renal polar artery was arising from the renal artery. Duplicated renal arteries were observed in 50% of cases and arising from abdominal aorta. This high incidence of presence of additional renal arteries are significant in the invasive interventions such as renal transplantation, interventional radiologic procedures and urologic operations,renal artery embolization, angioplasty or vascular reconstruction for congenital and acquired lesions,

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