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Research Article

Morphometric evaluation of the kidney and its main renal artery

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ABSTRACT

Background: With the increasing incidence of renal transplantations and advent of modern imaging techniques in the current era, the knowledge of renal artery variations in their position of origin from abdominal aorta, level of origin from the superior mesenteric artery, pattern of their division towards the renal hilum, and the additional branches from the renal arteries should be well known for preparing renovascular surgical and radiological interventions.
Methods: Fifty specimens from 25 adult human embalmed cadavers were taken from the department of anatomy and were studied by dissection method. Morphometric data of the specimens dissected were recorded using vernier calipers.
Results: Though morphometric analysis of both the kidneys was studied, it shows no significance from earlier studies. Accessory renal arteries were noted in 24% of cases with equal incidence on both sides. Within accessory, hilar type was most common (14%), followed by inferior polar in 12% and superior polar in 2% of specimens. Accessories in 28.5% specimens gave rise to gonadal arteries and 7.3% specimens to inferior phrenic artery.
Conclusion: The results suggest that there are a large number of anatomical variations in the vascularisation of the kidney. The most common incidence is the occurrence of accessory renal arteries. It was rarely found that superior and inferior polar arteries originated from the renal artery. The renal artery diameter is a factor which should be considered as predicting the presence of additional renal arteries.

Keywords: Renal transplantations, Renal arteries, Morphometric data, Kidney

INTRODUCTION

Renal arteries are usually arise from the anterolateral or lateral aspect of the abdominal aorta just below the origin of the superior mesenteric artery, at the level of L1-L2 intervertebral disc.[1]

With the advent of laparoscopic renal surgeries and donor nephrectomy, it becomes mandatory for the surgeons to understand the abnormality or variations in the renal vasculature, otherwise renal transplant may be jeopardized. The most common variation of renal artery is the presence of an accessory renal artery, which may enter through the hilum or through the surfaces of the kidney.

According to Graves any artery arising from the aorta in addition to the main renal artery should be named 'accessory' and the renal arteries arising from sources other than the aorta should be called 'aberrant'.[2]

The adult kidney has a length of 10-14 cm, width of 5-7 cm, and thickness of 2.5-3.0 cm.[3]

The anatomic nomenclature describing renal arteries other than the main ones - the left and right renal arteries - is confusing and controversial. In fact, sometimes the term "main" is used for clarification.

The renal pelvis and ureter is located further posterior to these vascular structures. Specifically, the right renal

artery leaves the aorta and progresses with a caudal slope under the IVC toward the right kidney. The left renal artery courses almost directly laterally to the left kidney.[4]

Each artery reaching the hilum divides into anterior and posterior divisions in relation to the renal pelvis. Furthermore, the five branches of each renal artery participate in the formation of four renal segments: (1) apical (superior), (2) anterior (subdivided into superior and inferior), (3) posterior, and (4) basilar (inferior).[1]

METHODS

Total number of adult human kidneys studied in the present work was 50, belonging to both sexes from 18 to 80 age group. Specimens were procured from 25 embalmed cadavers (one right and one left from each cadaver), given to both undergraduate and postgraduate students for dissection, during the period of 2011 to 2013 in the department of anatomy.

After the dissection and removal of spleen, liver, stomach, small intestine, large intestine and pancreas, the mesentery and rest of the peritoneum was stripped off from the posterior abdominal wall, to approach the retroperitoneal structures. The fascia was removed from the abdominal aorta. Blood vessels originating from the abdominal aorta to the kidneys (renal and accessory renal arteries) were identified and meticulously delineated. Fasciae covering the kidney along with suprarenal's were dissected and removed. It was keenly observed for any variation in the course of renal or accessory renal arteries with relation to inferior vena cava and gonadal veins. Later the inferior vena cava was cut 5cm below and 5 cm above the level of renal veins and removed along with renal and gonadal veins. Measurements of renal and accessory renal arteries were taken using Vernier calipers. Arteries originating from other than aorta (Aberrant renal arteries) and entering the kidney superior or inferior pole are classified as superior polar artery and inferior polar artery respectively. The description of the study done is with respect to the above classification.

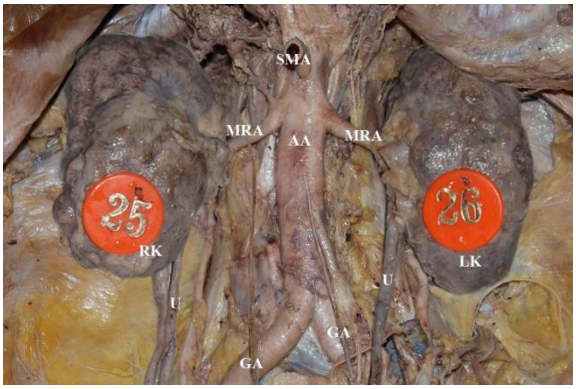

Figure 1: Dissected specimen showing the gonadal artery (GA) arising from main renal artery (MRA). RK - Right kidney, LK - Left kidney, SMA - Superior mesenteric artery, U - Ureter.

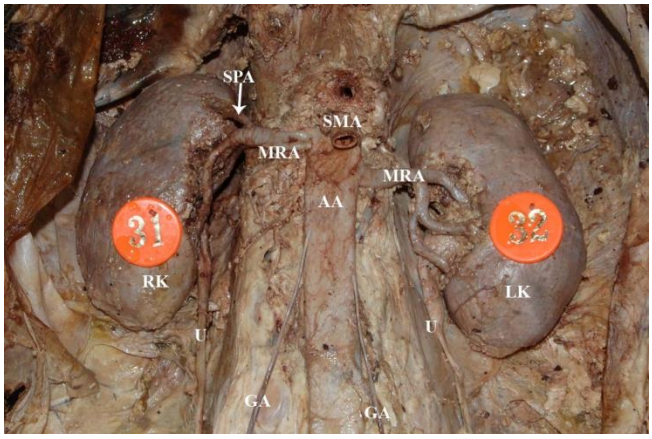

Figure 2: Dissected specimen showing the superior polar artery (SPA) arising from main renal artery (MRA). RK - Right kidney, LK - Left kidney, SMA - Superior mesenteric artery, U - Ureter.

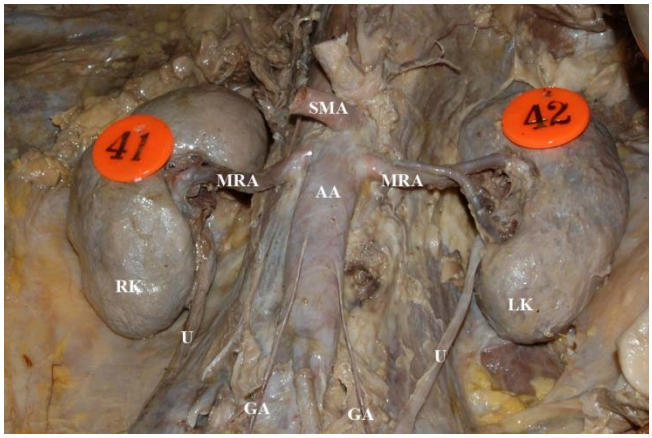

Figure 3: Dissected specimen showing the inferior polar artery (IPA) arising from main renal artery (MRA). RK - Right kidney, LK - Left kidney, SMA - Superior mesenteric artery, U - Ureter.

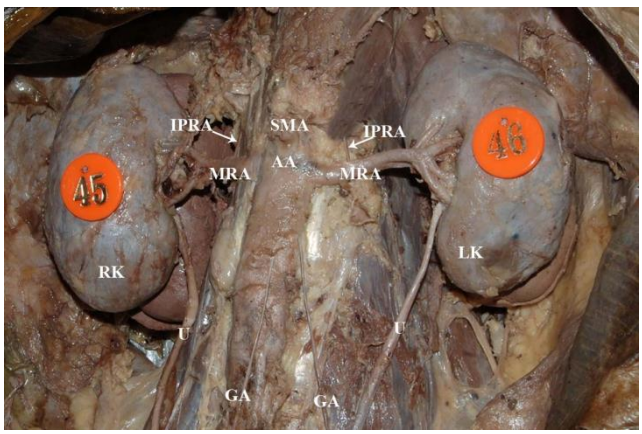

Figure 4: Dissected specimen showing the inferior phrenic artery (IPRA) arising from main renal artery (MRA). RK - Right kidney, LK - Left kidney, SMA - Superior mesenteric artery, U - Ureter.

RESULTS

Renal artery arising from the lateral side of abdominal aorta in 46 out of 50 specimens (92%), while it arose from the anterolateral side of abdominal aorta in 3 specimens (6%) and from the posterolateral side of abdominal aorta in 1 specimen (2%), indicating the lateral side being the commonest site of origin. The origin of renal artery was higher on the right side (15 specimens, 60%) when compared to that on the left side (7 specimens, 28%) with respect to superior mesenteric artery, while it was equal in 3 specimens (12%) on both sides (Table 1).

Table 1: Comparison of dimensions of right and left kidney.

Dimensions	Right side in cm	Left side	Right vs. left	
			T value	P value
Length	8.5 ± 1.1 (6.5-10.2)	8.9 ± 1.3 (6.4-11.5)	1.15	0.26
Breadth	3.6-6.5 (4.9 ± 0.6)	3.5-6.0 (4.8 ± 0.7)	0.19	0.89
Thickness	2.5-4.5 (3.5 ± 0.5)	2.6-0.5 (3.6 ± 0.6)	0.84	0.41

The average length of the renal artery on the right side ranging from 3 to 8.5 cm with an average length of 5.7 ± 1.2 cm. On left side, it was ranging from 3.2-7.0 cm with an average length of 5.0 ± 0.09 cm which is statistically significant. The right renal artery is comparatively longer than the left renal artery.

Majority of the renal arteries (45 out of 50 specimens) divided before entering the hilum, whereas only few (5 out of 50 specimens) divided within the hilum. Early division of the renal artery was observed more commonly. The renal artery on an average divides 2.1 cm (range 0-4.8 cm; 2.1 ± 1.2 cm) from the hilum on right side and 2.2 cm (range 0-4.8 cm; 2.2 ± 1.4 cm) from the hilum on left side. However this difference is not statistically significant.

The average caliber of renal arteries without accessories as 5.7 mm (range 5.0-0.7 mm; 5.7 ± 0.09), while average caliber of renal arteries with accessories as 4.7 mm (range 4.0-0.5 mm; 4.7 ± 0.004), indicating that renal arteries with lower caliber present with accessories. This is statistically significant.

Table 2 shows predominance of incidence of branches (Inferior phrenic artery, superior polar artery, inferior polar artery, and gonadal artery) on the right side (24%) as compared to the left side (8%).

Among them the commonest was inferior phrenic artery. Accessory renal arteries were found in 12 (24%) specimens only.

Table 2: Incidence of branches other than normal from renal artery.

Branches from renal arteries (other than inferior suprarenal, pelviureteric and capsular branches)	Right side		Left side		Total	
	No.	%	No.	%	No.	%
Number of branches	6	24	2	8	8	16
Inferior phrenic artery	3	12	1	4	4	8
Superior polar artery	1	4	1	4	2	4
Inferior polar artery	1	4	-	-	1	2
Gonadal artery	1	4	-	-	1	2
No branches	19	76	23	92	42	84

DISCUSSION

Variations in the origin and course of the renal arterial blood supply occur frequently and are of special interest to the urologists, nephrologists, surgeons and radiologists, with respect to the diseases associated with it.

The commonest site of origin of renal arteries is lateral (92%), and less commonly on anterolateral (6%) and posterolateral (2%) aspect of abdominal aorta, which correlates with earlier studies.[1,5]

In the present study right and left renal artery are reported to be at the same level in about 12% of cases, while the

right was higher in 60% of specimens and the left in 28% of specimens. The right renal artery was higher than the left renal artery in majority of the cases which correlates with the earlier studies.[5] The average length was found to be 5.7 cm on right side and 5.5 cm on the left side. The right renal artery is comparatively longer than the left renal artery which correlates with the earlier studies.[5]

Early division of renal artery was 11.6% and 12% in earlier studies.[6] In the present study it is seen in 45 specimens out of 50 (90%), indicating that the renal artery divides before its entry into the hilum more commonly than its division within the hilum.[7]

Average caliber of renal artery with accessories was less (4.7 mm), when compared to average caliber of renal artery without accessories (5.7 mm). This correlates with earlier studies by T. Ramesh Rao who found the renal artery of diameter less than 4.15 mm was associated with accessory renal arteries.[8]

The average length of left kidney was comparatively longer than the right kidney which correlates with earlier studies. The average breadth and thickness of the kidney is almost the same on both the sides.[1,5]

The renal artery may give rise to branches normally derived from other vessels, such as the inferior phrenic, hepatic, middle and inferior suprarenal, gonadal, pancreatic, and one or more of the lumbar arteries.[5] In the present study 8% of the renal artery gave inferior phrenic branches, while 2% of the renal arteries gave gonadal arteries.

The site of origin of accessory renal arteries is commonest from anterolateral aspect (50%) of abdominal aorta followed by lateral (42.8%) and posterolateral aspect (7.2%).

The average length of renal artery with accessories was 5.7 in comparison to main renal artery which was 5.1 as reported by Hitendra Kumar in the earlier studies. In the present study average length of renal artery with accessories was 5.6 in comparison to main renal artery which was 5.4. This infers that the accessory renal arteries are lengthier than main renal arteries.[9]

CONCLUSION

The results suggest that there are a large number of anatomical variations in the vascularization of the kidney. The most common incidence is the occurrence of accessory renal arteries. It was rarely found that superior and inferior polar arteries originated from the renal artery. The renal artery diameter is a factor which should be considered as predicting the presence of additional renal arteries. This knowledge should serve in preparation for interventions, such as live renal donation, vascular reconstruction, renovascular hypertension, urinary outflow disturbances, varicocele or radical nephrectomy. Preoperative renal imaging is necessary and should be carried out prior to operative techniques to avoid unintentional renal trauma.

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