



ANATOMICAL VARIATIONS OF THE RENAL ARTERIES IN HUMANS.

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ABSTRACT

Renal artery variations are becoming more important due to the gradual increase in interventional radiological procedures, urological and vascular operations, and renal transplantation. Such variations have great implication when surgery is indicated. Increase in frequency of renal diseases and renal transplants, there is a need of research work aimed at better and accurate knowledge of variations of the blood vessels supplying the kidneys. OBJECTIVE: To study the variations of renal arteries in various cadavers based on the level and source of origin, course and relations. The origin of right renal arteries from the aorta was between the upper margin of L1 and lower margin of L2 vertebra in 96.7% of the specimen. The most common location for the origin of renal artery was at the level of L1- L2 intervertebral disc. Renal artery variations included abnormal origin at the level of L3 vertebra in 3.3%, abnormal course and relations in 6.6% of the specimen.

KEYWORDS: Renal artery, Anatomical variations, kidney.



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INTRODUCTION

Artery which literally means "Air tube", are thick walled tubes which convey blood from the heart to the capillaries. All arteries arise from aorta and that they contain blood was mentioned by Galen in 170 A.D ¹. The renal arteries are the lateral branches of the abdominal aorta arising inferior to the origin of superior mesenteric artery. It is stated that different origins of renal arteries and frequent variations are explained by the development of mesonephric arteries ². These arteries form a vascular net feeding the kidneys, supra renal glands and gonads on both sides of the aorta between cervical-6 and lumbar-3 vertebrae, a region known as rete arteriosum urogenitale ³. Over time, these arteries degenerate, leaving only one mesonephric artery, which under takes arterial circulation of the kidneys. Deficiency in the development of mesonephric arteries results in more than one renal artery. Increase in frequency of renal diseases and renal transplants, there is a need of research work aimed at better and accurate knowledge of variations of the blood vessels supplying the kidneys. The incidence of anatomical variations in the renal vascular pedicle is greater than attributed to normal subjects in previous reports ⁴. The renal artery variations are to be kept in mind when surgery related to renal arteries is planned or a non-invasive diagnostic search is performed for renal artery stenosis. Knowledge of anomalous vessels serves as the road map before surgery, reduces the risk of trauma to the vessels and ensures thorough vascular ligation and anastomosis. Hence the knowledge of the occurrence of variations in the origin, course, relations and branching pattern of renal arteries is very essential in performing surgical procedures including transplantation of kidneys during infancy, childhood and in adults. The present study was under taken in view of the great importance of vascular supply to the kidneys with an objective to study the anatomical variations of renal arteries in humans. OBJECTIVE: To compare and contrast the right and left renal arteries in various cadavers based on the level of origin, source of origin, length, course and their relations.

MATERIALS & METHODS

The study was conducted in the Department of Anatomy. The specimens for the study of Renal Arteries in adult human were obtained from cadavers placed for dissection in the department. Permission was obtained from the Institutional Ethics Committee. Anterior abdominal wall was opened by giving the following incisions and both the kidneys were exposed as per the guidelines given in the Cunningham's manual of practical anatomy ⁵.

Incisions

1. A vertical incision from xiphoid process to the symphysis pubis surrounding the umbilicus.
2. A transverse incision from umbilicus to the right side and to the left side of the abdomen.

Steps

- The two upper skin flaps of the abdominal wall were reflected upwards and laterally and the lower two skin flaps were reflected downwards and laterally.
- The various viscera in the abdomen were removed to expose the kidneys.
- The renal arteries supplying the kidneys were traced.
- The abdominal viscera and the intestines were removed to expose the kidney on the posterior abdominal wall.
- Kidneys and suprarenal glands were palpated on the posterior abdominal wall.
- Right and left kidneys were separated from the perirenal fat and fascia using fingers.
- The suprarenal glands were separated from the kidneys carefully by inserting the fingers between them.
- The gross anatomy of both kidneys was studied in particular to their arterial supply.
- To visualize the arterial patterns of kidney the following procedure was adapted.
- Right and left kidneys were separated and removed from the posterior abdominal wall.
- Renal arteries were identified and irrigated with normal saline to remove the clots.

Data analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 17.0 statistical software. Mean and standard deviation were calculated for quantitative data. Mean values were compared between the two groups, using unpaired 't' test for the difference in the mean scores. The statistical test was two-tailed, and the results were considered significant at $p < 0.05$.

RESULTS

The total number of specimens studied were 30, out of which 25 were male and remaining 5 were female. Age of the cadavers ranged

from 35-50 years. In the present study the following observations were made.

1. Level of Origin

Normally, renal arteries arise laterally from the abdominal aorta between L1 and L2 vertebrae. In the present study the right and left renal arteries were arising from the lateral side of the abdominal aorta between L1 and L2 vertebrae, in 29 specimens. In one specimen, the right renal artery was seen arising laterally just above the inferior mesenteric artery at the level of L3 vertebrae and the left renal artery was arising laterally between L1 and L2 vertebrae. These observations are shown in table 1. The origin of right renal artery arising at L3 level is shown in figure 1.

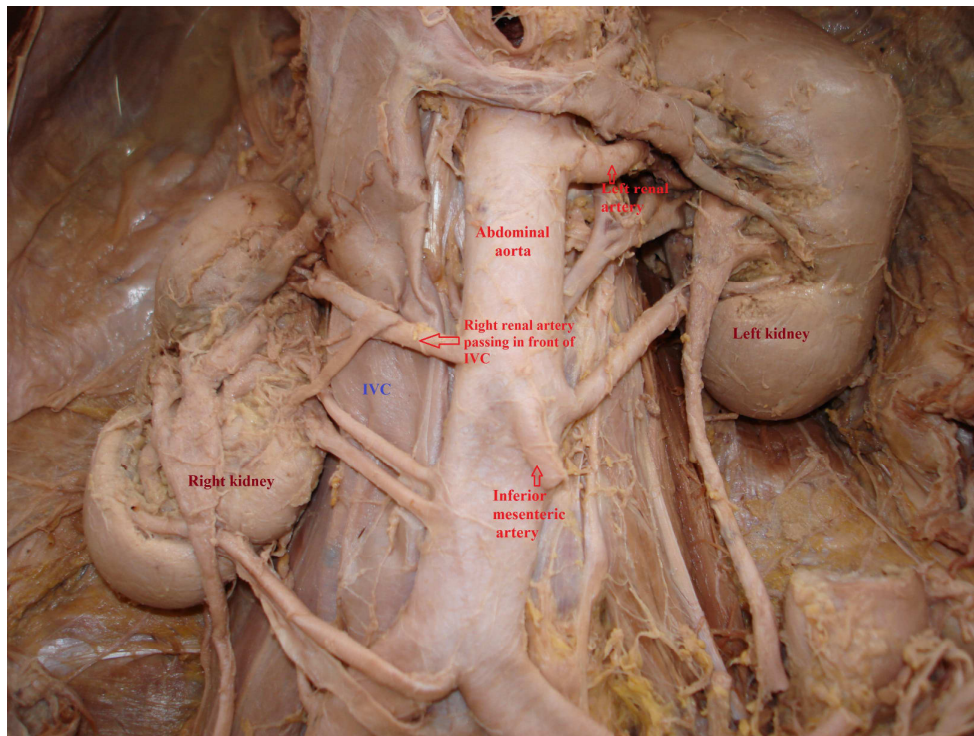


Figure.1
Showing the abnormal origin of right renal artery

Table 1
Showing the levels of right and left renal arteries

	Level of Origin between L1 & L2 vertebrae		Variations in level of origin at level of L3 vertebrae	
	Right renal artery	Left renal artery	Right renal artery	Left renal artery
No. of Specimen	29	30	1	0
Percentage (%)	96.7	100	3.3	0.0

2. Source of Origin

The right and left renal arteries normally arise from the lateral aspects of abdominal aorta. In the present study, all the specimens showed the normal source of origin of both right and left renal arteries as shown in table 2.

Table 2
Showing the source of origin of right and left renal arteries

	Normal source of origin (Abdominal aorta)		Abnormal Source of Origin	
	Right renal artery	Left renal artery	Right renal artery	Left renal artery
No. of Specimen	30	30	0	0
Percentage (%)	100	100	0.0	0.0

3. Length of Renal Arteries

Normally the length of right renal artery from its origin is longer than the length of the left renal artery. In the present study, the length of the right and left renal artery were measured and the mean length was calculated. The

mean length of the right renal artery was higher (5.7 cm) than that of left renal artery (4.1 cm). The difference in the mean length of right and left renal artery was statistically significant. The same results are shown in table 3.

Table 3
The difference in mean length of right and left renal arteries.

	Length of Renal arteries		t value	P value
	Right renal artery (cm)	Left renal artery (cm)		
N	30	30		
Mean± SD	5.7 ± 0.6	4.1 ± 0.6	9.44, df-58	< 0.01 Highly significant

4. Course and Relations of Renal Arteries

Right renal artery normally passes laterally in front of the right crus of diaphragm behind the IVC, head of the pancreas and the second part of duodenum and reaches the hilum of the kidney between the renal vein in front and the pelvis of ureter behind. Left renal artery normally passes laterally in front of the left crus of diaphragm behind the body

of pancreas, left renal and splenic veins and it is crossed in front by the inferior mesenteric vein and reaches the hilum of the kidney between the renal vein in front and the pelvis of ureter behind. In the present study in 28 specimens, the course and relations of right and left renal arteries are normal as per the standard textbook description. In one specimen, the right renal artery was noticed

passing in front of the Inferior Vena Cava (IVC) and reached the upper part of the hilum of the right kidney. Two renal veins are leaving the hilum of the kidney crossing in front of the right renal artery and ending in the IVC. In another specimen on the left side,

the renal artery after arising from the aorta passed laterally and crossed the renal vein anteriorly to enter the hilum. The variations in the course and relations are shown in table 4. The same findings are shown as photographs in figure 1 and 2.

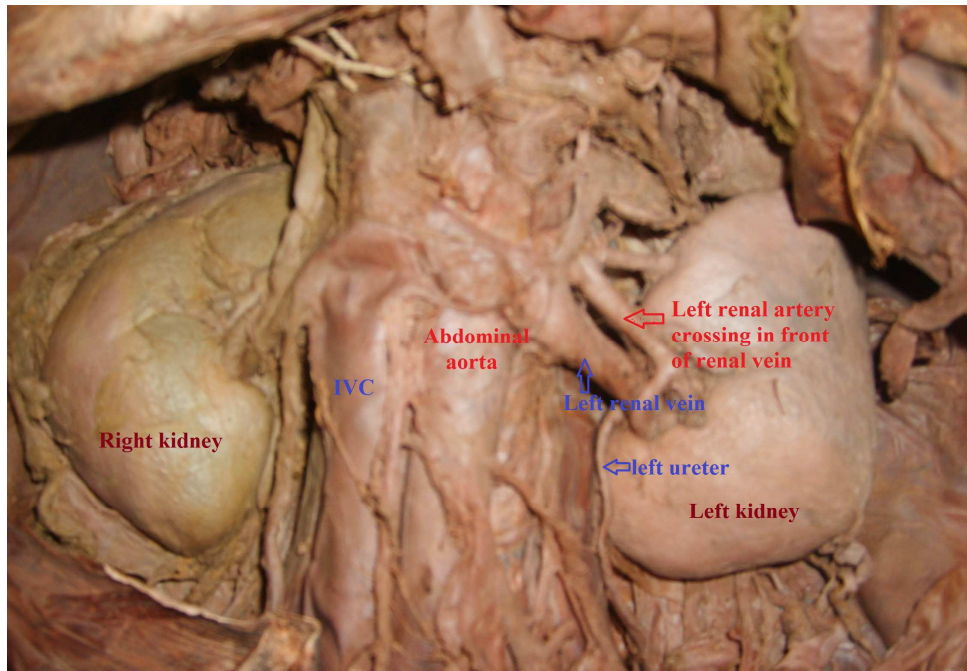


Figure 2
Showing the abnormal relations of left renal artery.

Table 4
Showing the course of right and left renal arteries and their relations.

	Course and relations		Variations in course and relations	
	Right renal artery	Left renal artery	Right renal artery (Passing in front of IVC)	Left renal artery (Crossing in front of renal vein)
Specimen no.	29	29	1	1
Percentage (%)	96.7	96.7	3.3	3.3

DISCUSSION

The origin, course, relations and variations of renal arteries have been extensively studied in the present study. It was observed that in 1 specimen the right renal artery is arising from the aorta laterally just above the inferior mesenteric artery at the level of L3 vertebra. Literature is not available to compare this observation with different authors. In the same specimen, left renal artery showed a normal

origin between L1 and L2 vertebrae. Most of the abnormalities in the renal arteries are due to the various developmental positions of kidney⁶. With regards to the origin of the right and left renal arteries normally is between L1 and L2 vertebrae are in conformity with the observation of some authors^{7, 8, 2}. Holleinshead⁹, Romanes G.J⁵ and Varma R.et.al¹⁰ described that the level of origin was

opposite the L2 vertebra. Henry Gray¹¹, A.K.Datta¹², F. J. Sampaio¹³ and Satheesha Nayak¹⁴ described that the origin is below the superior mesenteric artery. According to Hollinshead⁹, the level of origin of renal artery is important topographically as right renal arteries which arise at a lower level typically pass in front of the inferior vena cava instead of behind it. He also gave a developmental explanation that the inferior vena cava below the level of kidney usually develops from a dorsally placed supracardinal system of veins while that at the level of kidney develops from a ventrally placed subcardinal system of veins. Thus inferior venacava is placed ventral to right renal artery at a higher level and dorsal to it at a lower level. Right renal arteries crossing anterior to the vena cava have been implicated in as one of the causes of uretero-pelvic junction obstruction¹⁵. A right renal artery that passes ventral to the inferior vena cava is important for pre-surgical planning, because of chances of its injury especially during the retroperitoneal approach, when only the right gonadal vein is expected to lie in the precaval area. This anterior origin may also result in misidentification at laparoscopy of such vessels as the inferior mesenteric, superior mesenteric or hepatic artery¹⁵. The abnormalities in the renal arteries are mainly due to the various developmental positions of the kidney. The standard textbooks of Henry Gray¹¹, Richard.S.Snell¹⁶, Keith.L.Moore⁶, A.K.Datta¹² and many authors like W.H. HolleinShead⁹, J. Aubert¹⁷, J.P.Beregi et.al.⁷, Ozkan.U² described that the right and left renal arteries are arising from the lateral aspect of the abdominal aorta. In the present study also all the specimens showed the source of origin of right and left renal arteries were from the lateral aspect of the abdominal aorta. But a contrast finding was described by S. Nayak¹⁴ that the right and left renal arteries arise from the anterior aspect of the abdominal aorta. The right renal artery is longer than that of the left renal artery. In the present study accounting all the specimens, the mean length of right renal artery \pm Standard deviation (SD) was 5.7 ± 0.6 cm and that of left renal artery was 4.1 ± 0.6 cm.

Similarly Pushpa Dhar and Kumud Lal¹⁸ had reported that the mean length of main right renal artery was 4.3 cm and that of left renal artery was 3.4 cm. In the present study except in 2 specimens, the relations of the right and left renal arteries are normal and in conformity with the text book descriptions. In 1 specimen right renal artery was passing in front of the inferior vena cava (IVC) and reached the upper part of the right kidney. This observation is in agreement with the findings of Standing 19 and Verma.R 9. In another specimen the left renal artery after arising from aorta passed laterally and crossed the renal vein anteriorly to enter the hilum. This observation is in conformity with that of S. Das and S.Paul²⁰. Right renal arteries crossing anterior to the vena cava have been implicated in as one of the causes of uretero-pelvic junction obstruction. Hence in most of the situations, it is the comprehensive knowledge of the renal arterial pattern which remains the key issue in determining the technical feasibility of surgical interventions as well as the post operative management.

CONCLUSION

The variations of renal vascular anatomy is important in the 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. Renal arteries originated between the first and the second lumbar vertebral levels in most patients. The vascular patterns are of importance in planning and performing all surgical procedures in the upper abdomen. Knowledge of anomalous vessels serves as the road map before surgery, reduces the risk of trauma to the vessels and ensures thorough vascular ligation and anastomosis. The findings of the present study have implications to anatomists and may also be useful to clinicians for invasive technique and for vascular surgeons.

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