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# INCIDENCE OF VARIATIONS IN THE ORIGIN AND COURSE OF ACCESSORY RENAL ARTERIES –A CADAVERIC STUDY

**Anatomy**

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## ABSTRACT

**Background:** The accessory renal arteries usually arise from the aorta, above or below the main renal artery and follow it to the renal poles or hilum. Many authors state that such vessels may be important from the clinical point of view as their presence may cause hydronephrosis, renovascular hypertension, varicocele, secondary haemorrhage and death due to unligated accessory renal arteries in nephrectomy and renal transplantation. **Material and methods:** Fifty specimens from 25 adult human embalmed cadavers were taken from the department of anatomy at Nalanda medical college and Hospital Patna, Bihar. Study duration of two years. and studied by dissection method. Morphometric data of the specimens dissected were recorded using vernier calipers. **Conclusion:** With the increasing incidence of renal transplantations and advent of modern imaging techniques in the current era, the knowledge of accessory renal arteries should be well known for preparing renovascular surgical and radiological interventions.

## KEYWORDS

Renal artery, Accessory renal artery, Nephrectomy.

## INTRODUCTION

Renal arteries are a pair of lateral branches from abdominal aorta, at the level of L1-L2 intervertebral disc, supplying right and left kidneys situated on either side of vertebral column1.

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 by the presence of aberrant or accessory vessels. Existence of the accessory arteries is accountable in cases of renal pathologies, radiological interventions, renal transplants, and other surgical approaches on them2.The renal arteries usually arise from the anterolateral or lateral aspect of the abdominal aorta just below the origin of the superior mesenteric artery. Usually one renal artery supplies each kidney which enters through its hilum. Abnormalities of the renal arteries are perhaps more frequently met with than those of the larger arterial trunks. Irregularities of the renal arteries are met with in about 25 percent and the commonest is the presence of additional vessel.3 Prof. Macalister in his account of multiple renal arteries mentions that of all the accessory branches, additional vessels from the aorta are the most commonest4. 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. A fatal haemorrhage occurred after operation from a torn artery to the lower pole of the kidney6.Ekehorn and W.J. Mayo have shown clearly the occurrence of hydronephrosis due to accessory renal artery to the lower pole of kidney6.Israel, in his book published in 1901, refers to a case where postoperative haemorrhage from an overlooked accessory renal vessel necessitated nephrectomy7.A lack of such information accounts for a relatively large percentage of the accidents both during and after operations upon the urinary tract where supernumerary arteries arise from the aorta and iliacs and enter the upper or lower poles of kidney or both poles independently of the main vessel. Different studies have given different incidences of accessory renal arteries ranging from about 11% to 61%1. Such high incidence certainly warrants proper understanding of this anomaly and its clinical implications. The adult kidney has a length of 10-14 cm, width of 5-7 cm, and thickness of 2.5-3.0 cm. Its approximate weight is 135 g in women and 150 g in men. Each kidney has two surfaces (anterior and posterior), two borders (lateral and medial), and two poles (superior and inferior); each kidney also has its own relations with several other anatomic entities. The kidney is related anteriorly to the abdominal viscera and posteriorly to the osteomuscular area. The right kidney lies at a lower level in comparison with the left, a phenomenon that permits the right lower pole to be palpable8. The renal arteries are end arteries without collateral circulation. 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).The anterior division branches supply the apical, basilar, superior, and inferior portions of the anterior segment. The posterior division supplies the posterior segment of the kidney. The very short apical artery supplies the anterior and posterior surfaces of the apical segment. The posterior segmental artery is usually the first branch of the main renal artery.

## OBJECTIVES

To understand and contrast the variations in the origin and course of right and left renal arteries in human cadavers. To study and compare the variations in the origin and course of accessory renal arteries if found.

### Review of Literature

The first anatomical findings on the renal artery, and the fact that one kidney can be provided with more than one renal artery, were shown by Eustachius on 1552, in anatomy illustrations engraved in copper12. Arteries send off their branches at a longer or shorter distance, according to circumstances; or in other words, they divide and subdivide more quickly in some places than in others. They divide also quickly in the substance of the brain. In the kidney this is also remarkable: they would seem in that gland to be hurrying to their termination. It has generally been thought that the venous system presents greater and more numerous anomalies in its distribution than the arterial ; and this observation is undoubtedly true as far as regards the superficial and smaller vessels, but not as regards the deep-seated and more considerable trunks. The renal and brachial arteries are much more irregular than the corresponding veins. We may observe, perhaps as a general principle that arteries near to their destination, where they are to perform their particular functions, do not anastomose. Thus the artery of the kidneys, the vena portae (This vessel should be considered as an artery), the arteries in the substance of the brain, do not anastomose, nor do the arteries on the villous coat of the intestines 13. Irregularities of the renal arteries are the commonest varieties met with among the abdominal vessels; indeed, these arteries present some form of variation in three cases out of every seven, leaving one out of those varieties which are associated with misplaced or horse-shoe kidneys. Variations in the number, source and course of renal arteries are common. The right and left renal arteries may arise from the aorta by a common stem. They may arise from the aorta at a lower point than usual. There may be several renal arteries on each side, or the renal artery may divide, close to its origin, into several branches. The renal artery on one or both sides may arise from the bifurcation of the aorta or from the common iliac, internal iliac, inferior mesenteric, or middle sacral artery. Branches of the renal artery may perforate the substance of the kidney instead of entering at the hilus. Accessory renal arteries vary in size and are generally derived from aorta (25% of all reported cases), and may enter the kidney at almost any point. Variations in the number of renal arteries and their positions with respect to the renal veins are common. Supernumerary arteries, usually two or three, are

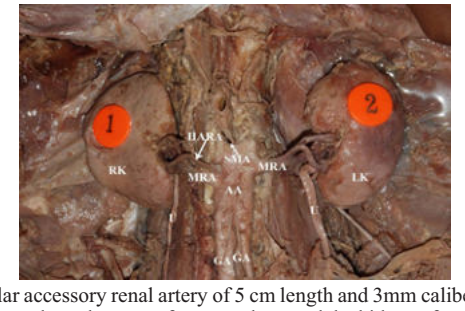
about twice as common in the kidney. During development, in the pelvis, the kidney receives its arterial supply from the aorta at continuously higher levels. The right kidney was found to receive two RRA, superior and inferior, both arising from abdominal aorta, from it is lateral and ventral aspects, respectively; and both were reaching the hilum of right kidney (right hilar arteries) after crossing the inferior vena cava from its anterior aspect (precaval RRA). The superior right hilar artery gave a branch to the upper pole of the right kidney (superior pole extra-hilar branch). The inferior precaval RRA reached the hilum of right kidney after crossing the ureteropelvic junction, from its anterior aspect. On the other hand, the left kidney was found to receive four LRA; upper three were arising from lateral side of abdominal aorta while lowest one arising from ventral aspect of abdominal aorta. From superior to inferior, first, third and last LRA were reaching the hilum of left kidney.

## MATERIALAND METHODS

Total number of adult human kidneys studied in the present work was 50, belonging to both sexes from 18 to 80 age group, all the 50 specimens were procured from 25 embalmed cadavers (one right and one left from each cadaver), given to both undergraduate and postgraduate students for dissection, in the department of Anatomy, at Nalanda medical college and Hospital Patna, Bihar. Study duration of two years. Dissection instruments used were Scalpel,Scissors- small and large straight scissors Forceps - pointed, toothed and blunt.*(Cotton dipped in water to clean the dissected area)Vernier caliper was used to take the measurements after the dissection of renal and accessory renal arteries. The renal and accessory renal arteries of the kidneys were studied by dissection method. 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. Measurements of renal and accessory renal arteries were taken using vernier calipers. The specimens were then numbered accordingly and photographs were taken insitu. With the renal and accessory renal arteries intact, the segment of aorta (from above the superior mesenteric artery to 7 cm below the origin of renal arteries) was cut. The renal pelvis and proximal 5cm of ureter was removed along with the kidneys, aorta, renal and accessory renal arteries.

## RESULTS

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. Alternative nomenclatures have been used to describe the accessory renal artery as supernumerary, multiple, aberrant, additional etc. 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 'aberrant5. Anomalies of arteries of the kidneys are very common. Under normal conditions there is a single artery arising from the aorta and dividing in variable manner into three terminal branches, pre and retro-pelvic and superior polar. 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. **Specimen 1and 2 Right kidney** length was 6.5cm, width 4.0cm and thickness 2.5cm. Right renal artery arose from lateral aspect of abdominal aorta, 1.5 cm below superior mesenteric artery. It was of 3.5cm length and 5mm in diameter.




One hilar accessory renal artery of 5 cm length and 3mm caliber arose from anterolateral aspect of aorta and entered the kidney after passing behind the inferior venacava. Left kidney length was 6.4cm, width 5.0cm and thickness 3.0cm. Left renal artery was of 4.4cm length and 6mm caliber. Anterior division of left renal artery was precaval. Left renal artery was at higher level compared to right renal artery. Specimen 2 and 3, Right kidney length was 7.0cm, width 5.0cm and thickness 3.3cm. Right renal artery arose from lateral aspect of abdominal aorta, 1 cm below superior mesenteric artery. It was of 6.5cm length and **Specimen No: 1 and 2** 5mm caliber, traversed a normal course to end in hilum. It was at higher level as compared to left renal artery.**Left kidney** length was 8.7cm, width 6.0cm and thickness 3.5cm. Left renal artery arose from lateral aspect of abdominal aorta, 1.5 cm below superior mesenteric artery. It was of 4.7cm length and 5mm caliber, traversed a normal course. Accessory renal arteries were absent in this cadaver. One superior polar artery 2.8cm arose from renal artery and entered at the upper pole of kidney.

**Site Of Origin Of Renal Artery From Abdominal Aorta (anterolateral, Lateral Or Posterolateral).**

| Site of origin of renal artery on aorta | No. of renal arteries | percentage |
|---|---|---|
| Anterolateral | 3 | 6 |
| Lateral | 46 | 92 |
| Posterolateral | 1 | 2 |
| **TOTAL** | **50** | **100** |

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.

**Average Caliber Of Accessory Renal Arteries**

| Average caliber (mm) | Superior polar accessory renal artery(mm) (n=1) | Hilar accessory renal artery (mm) (n=7) | Inferior polar accessory renal artery (mm) (n=6) |
|---|---|---|---|
| **Average ± SD** | **2.0** | **3.0 ± 0.1** | **3.0 ± 0.1** |
| **Range** | **-** | **3.0 – 4.0** | **2.0 - 5.0** |

average caliber of superior polar accessory renal artery as 2.0 mm, hilar accessory renal artery as 3.0 mm and inferior polar accessory renal artery as 3.0 mm.

## 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 relevance of the accessory arteries in systemic hypertension and urethral obstruction is well established. With the advent of laparoscopic renal surgeries, donor nephrectomy and renal transplantations, it becomes mandatory for the surgeon to understand the abnormality or variations in the renal vasculature. Otherwise renal transplant may be jeopardized by the presence of accessory renal vessels. 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.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[14]. Average caliber of renal artery with accessories was less (4.7mm), when compared to average caliber of renal artery without accessories (5.7mm). This correlates with earlier studies by T. Ramesh Rao who found the renal artery of diameter less than4.15 mm was associated with accessory renal arteries.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.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[14] .In the present study 8% of the renal artery gave inferior phrenic branches, while 2% of the renal arteries gave gonadal arteries. The average length of superior polar accessory renal artery was 3.0 cm, hilar accessory renal artery was 6 cm and inferior polar accessory renal artery was 5.6 cm. The hilar accessory renal artery being longest of the three. 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. The reason for occurrence of accessory renal arteries is explained in the literature as; the lateral splanchnic arteries from the abdominal part of the developing aorta supply the structures developing in whole or in part from the intermediate cell mass i.e., the suprarenal gland, the kidney and the gonads (ovary or testis). These arteries are well developed only in the regions of developing pronephric, mesonephric and metanephric. They form irregular series of vessels in the adult (rete arterio urogenitale).

## 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.The most frequent are hilar and lower polar accessory renal arteries originating from the aorta.It was rarely found that superior and inferior polar arteries originated from the renal artery.

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