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Original Research Article

EXTRA HILAR BRANCHING OF RENAL ARTERIES: AN ANATOMICAL STUDY

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ABSTRACT

Introduction: The objective of this study was to observe the patterns of different arteries that supply the kidneys. The kidney has a segmental distribution of arteries. The kidneys are divided into five vascular segments. The arteries that arise from the aorta above or below the main renal artery and reach the hilum are called accessory renal arteries. They are persistent embryonic lateral splanchnic arteries. Accessory renal arteries may arise from the celiac or superior mesenteric arteries, near the bifurcation or from the common iliac arteries. The present study has attempted to find out accessory, and aberrant arteries to kidneys with review of literature.

Materials and Methods: The study was done on 52 kidneys randomly selected from cadavers that were used for the purpose of teaching in the department of Anatomy at P.E.S Medical College. The kidneys were removed from the cadavers en-block with the arteries and veins intact. The renal artery was observed for its pattern of branching.

Observations and Discussion: The pre-hilar branching pattern was absent only in six kidneys out of the 52 kidneys selected. The branches given before entering the hilum were either in the form of a fork pattern or a ladder pattern in the remaining 46 kidneys. The fork pattern wherein the branches arose from a single point was found in 42 kidneys. The ladder patterns were seen in two posterior segment arteries and two anterior segment arteries. The anterior division often showed the fork patterns which were either duplicate or triplicate outside the hilum more proximally, with further division into duplicate or triplicate terminal branches closer to the hilum but significantly outside.

KEY WORDS: Polar arteries, Vascular patterns, Accessory Renal Arteries, Hilum, Segmental Arteries.

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INTRODUCTION

Renal artery variations have been studied by various authors in the past. The objective of this study was to determine the number of different arteries that supply the kidneys and the patterns they form while supplying. The arteries supplying kidneys are derived from the lateral splanchnic branches from the dorsal aorta as it ascends to the adult position in the lumbar region. The kidneys are supplied by arteries that arise from the lateral side of aorta at the level of lumbar vertebrae, between the upper margin of L1 and the lower margin of L2. They run at right angles to aorta and in 70% of individuals a single artery

supplies the kidney on each side. The kidney has a segmental distribution of arteries. The kidneys are divided into five vascular segments. They are named apical, superior, middle, lower and posterior. The apical segment is formed by the anterior and medial region of the superior pole. The superior segment is formed by the superior pole and the central antero-superior region (anterior segment).The whole of lower pole forms the inferior segment. Between anterior and inferior segments is the part of kidney that forms the middle anterior segment. The whole posterior region between apical and inferior segments is the posterior segment. These segments get their blood supply from the segmental arteries which arise from the anterior and posterior divisions of the main renal artery. These segmental arteries are end arteries. They do not anastomose freely. The renal medulla is supplied by long wide vessels passing from the efferent glomerular arterioles. The arteries that arise from the aorta above or below the main renal artery and reach the hilum are called accessory renal arteries. They are persistent embryonic lateral splanchnic arteries. If the vessels cross anterior to the ureter at the lower pole, it may cause obstruction to the ureter and cause hydronephrosis. Accessory renal arteries may arise from the celiac or superior mesenteric arteries, near the bifurcation or from the common iliac arteries [1].

In 30% of individuals accessory arteries have been reported [1]. These arise from the aorta above or below the main renal artery and go to the hilum and are regarded as persistent embryonic lateral splanchnic arteries. Two groups of renal artery variations are considered. They are early division and extra renal arteries (ERA). The extra renal arteries are further divided into hilar and polar arteries. The hilar arteries are considered accessory arteries. The arteries that enter the poles of the kidneys are considered as aberrant arteries [2]**.** The polar arteries enter the kidneys directly from the capsule outside the hilus. The present study has attempted to find out accessory, and aberrant arteries to kidneys with review of literature.

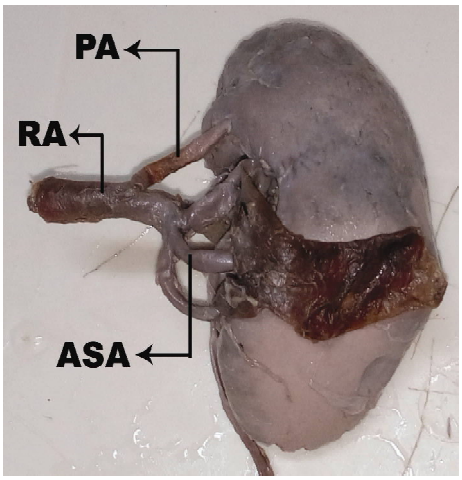
MATERIALS AND METHODS

Formalin fixed cadavers which were used for teaching purpose during routine dissection in P.E.S Institute of Medical Sciences & Research, India were used for the study. 52 kidneys from various cadavers were removed along with their arteries from their location. The arteries of the kidneys were then observed for variation in branching before entering the hilum, at the hilum and also entry at other points especially the poles. The kidneys with variations were photographed. The accessory arteries and aberrant arteries were noted and photographed.

RESULTS

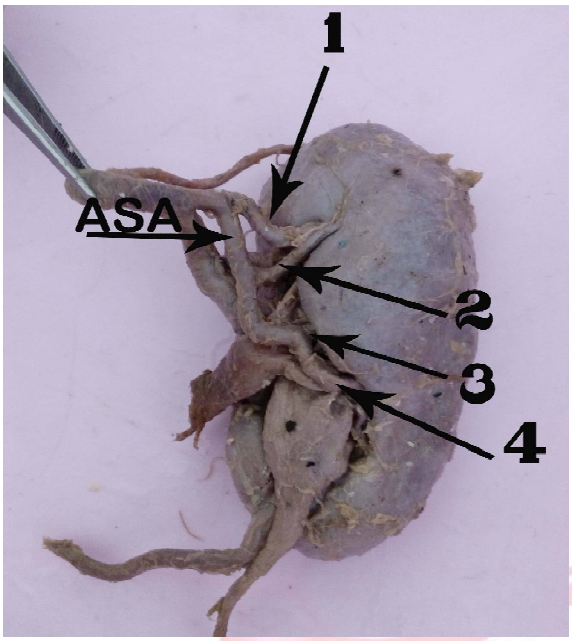
It was observed that 12 kidneys out of the 52 had arteries which entered the upper pole of the kidneys. Of the 12, right side kidneys were 2 and left side kidneys were 10. Of the 12 kidneys there were five left kidneys in which the posterior division gave duplicate and triplicate branches at the hilum. One left kidney had an artery that entered the lower pole of the kidney which was a direct branch from the aorta. The arteries that entered the upper poles took origin from the main renal artery proximal to the origin of anterior segmental artery. The anterior segmental and the posterior segmental arteries divided outside the hilum to supply their vascular territories. The arteries showed fork pattern and ladder patterns. The fork patterns were more frequent than ladder patterns. The branches were identifiable as apical, upper, middle, lower branches. Of the branches that were given by the posterior division one branch was directed upwards towards the upper segment at the hilum.(FIG-3) The area of supply was not traced in this study.

Fig. 1: Showing the branching pattern.



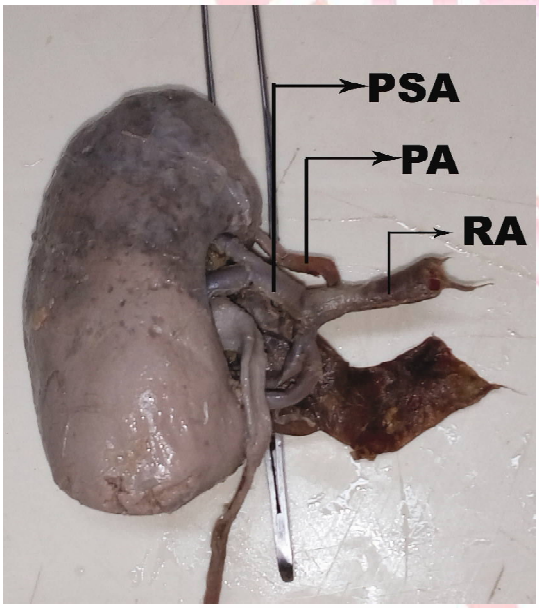
ASA: Anterior Segmental Artery (Fork pattern), RA: Renal Artery, PA: Polar Artery,

Fig. 2: Showing the branching pattern.



ASA- Anterior Segmental Artery
1,2,3,4- Branches – in ladder pattern.

Fig. 3: Showing the branching pattern. PSA: Posterior Segmental Artery giving branch to upper pole.



PSA- Posterior Segmental Artery, PA- Polar Artery,
RA- Renal Artery

OBSERVATIONS AND DISCUSSION

Ozkan et al [2] found in their angiographic study of 855 patients that 24% of patients had more than one renal artery. The right side had more than one artery compared to the left side. The occurrence of more than one artery on both sides was only 5%. They observed 71 aberrant and 69 accessory arteries on the right side and 58 aberrant and 58 accessory arteries on the left side. In the present study of the 12 polar arteries 10 were seen on the left and 2 on the right. The polar arteries took origin from the main renal artery (FIG-1) and can be considered normal segmental branching based on their origin. Irena Vilhova et al [3] have described renal arteries as double, triple, accessory and perforating arteries. Double renal arteries originated from the aorta, were identical in diameter, blood supply areas, and gave branches that entered the hilum. The triple renal arteries varied in their diameters and areas of supply but branches entered the hilum. Accessory renal artery arose from the aorta, entered the hilum and supplied only one segment either upper or lower pole. A perforated renal artery originated from the aorta, entered the kidney outside the hilum and was comparable to a segmental artery supplying only one segment. The vessels which are aberrant are longer and narrower and the renal segments receiving these vessels have lower levels of blood pressure than the rest of parenchyma, thus increasing rennin secretion. They have opined that an anatomical reason could be the cause for disorders like hypertension and that there is a need to introduce terms for classifying plural renal arteries. In the present study the renal arteries that entered the kidney outside the hilum went to the upper pole (FIG-1) and these were considered polar arteries because they arose from the main renal artery as a separate branch more proximal to the anterior division. They cannot be considered aberrant as they were from the main artery and they cannot be additional or accessory as they did not arise from the aorta and did not enter the hilum.

Saldarriaga, B et al [4] They have also observed that the renal pole was frequently supplied by the anterior division. They observed a direct branch from the renal artery-superior renal polar branch on the right-hand side in 17.2% and in 13.5% on the left hand side. The inferior polar branch was seen in 5 specimens each on the right and left sides. In the present study the superior polar branches were from the main renal artery and the inferior polar branch was seen in only one specimen on the left. This had taken origin from the aorta directly. So this can be considered an accessory artery to the lower pole.

Saldarriaga et al [5] observed additional arteries.

The frequency of more than one additional artery was 87(22.3%) and 2 additional arteries was 10 (2.6%). They found that additional arteries had greater length than main arteries. The additional arteries ran parallel or divergent to the main renal artery. They have also observed early ramification of the main renal artery and considered it important in diagnostic imaging and surgical complications during transplants. The first 15mm of the renal artery is used for anastomosis with the recipient's iliac artery. In the present study there was one kidney with an additional anterior segmental branch which gave the middle and lower branches.

Shoja et al [6] studied the variations in peri-hilar branching patern and morphology of the main artery. They classified the branching as ladder and fork patterns. The pattern where there were sequential branching points was termed ladder type. The pattern with a common branching point was termed the fork type. The fork was either duplicate or triplicate depending on the number of branches. They divided their observations into cardinal peri-hilar morphology (more than 5%) and infrequent morphologies (less than 5%). They observed that the main artery was of the fork pattern in 92.6%(75), duplicated in 80.2%(65) triplicated in 12.4%(10) and ladder pattern was 7.4%.(6). In the present study the fork pattern was seen in 42 kidneys(FIG-1) and 4 kidneys had ladder pattern.(FIG-2) There was no perihilar branching in only six kidneys. Therefore it can be considered that branching outside the hilum is a normal pattern where the arteries divide to go to the respective segments.

Julius A.Ogeng'o et al [7] have reported single, double, triple, and quadruple renal arteries. The double renal arteries were parallel, overlapped, initially superimposed then divergent and crossed types. Of the double arteries there were superior polar and inferior polar types. The single renal arteries were hilar, prehilar, and parenchymal branching types. The prehilar branching pattern showed terminal branches either before or after the hilum. The bifurcation pattern, fork and ladder patterns with overlapping of primary branches was observed. There were upto seven extraparenchymal branches reported in their study. In the present study the posterior division was observed to be having duplicate and triplicate branches in fork and ladder patterns in 11 kidneys. They can be considered extra parenchymal branches as the posterior division gives only one segmental branch normally.

Budhiraja V et al [8] also reported that superior polar arteries took origin from apical segmental branch in five out of the seven cases. In two cases they originated directly from the aorta. The present study found polar arteries arising from anterior segmental arteries. All the polar arteries entered outside the hilum and penetrated the capsule of the kidney.

Neerja Rani et al [9] identified variations in origins of segmental arteries. They observed the anterior division gave four branches apical, upper, middle and lower segmental arteries. In the present study the anterior division gave three branches and in 12 kidneys the polar branch as a separate branch from main renal artery.

Shinde Amol A et al [10] have reported from a study of 50 kidneys, lower polar supernumerary arteries in 4% of their specimens. They have cited the explanation given by Felix based on embryological development. The arteries supplying the kidneys of an 18mm fetus are from the dorsal aorta. There are nine pairs of arteries called the lateral mesonephric arteries. According to Felix the first two pairs are called cranial, the 3rd to 5th are called middle, and the 6th to 9th are called the caudal group. The middle group supplies the kidneys. If more than one artery persists then supernumerary arteries can result. There was only one lower polar artery in the present study.

CONCLUSION

The arteries supplying the kidneys divide outside the hilum frequently. The main division of the artery into anterior and posterior divisions was maintained consistently without variation. The only significant variation could be the polar arteries which pierced the capsule of the kidneys. They could be considered aberrant arteries as they have may a different course and termination. There may be significant changes in the perfusion of kidneys with such an arterial pattern. The normal direction of flow from the apex of the pyramid to the cortico-medullary

junction and the cortex becomes reversed in this case.

Conflicts of Interests: None

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