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Original Research Article

ANATOMICAL VARIATIONS OF BRANCHING PATTERN OF MAIN RENAL ARTERY IN HILUM AND PREHILAR AREA

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ABSTRACT

The hila and adjacent pre-hilar parts of 72 kidneys (35 right and 37 left) isolated from formalin fixed cadavers were examined. The hilum and prehilar area of each kidney was dissected to observe the total number of branches of the main renal artery. This information is useful in nephron sparing surgeries such as partial nephrectomy by laparoscopic approach. Subsequently, prehilar branching of the main renal artery before it enters the hilum was observed in 48.6% of kidneys with a higher incidence of 51.3% in left kidneys as compared with the incidence of the right side (45.7%). We further observe the variations of branching patterns in the main renal artery and calculate the incidences. Finally, our results are compared with that of similar studies conducted previously.

KEY WORDS: Hilum, Renal Vein, Renal Artery, Laparoscopic, Nephrectomy.

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INTRODUCTION

The study of renal vasculature has become critically important in surgical planning of partial laparoscopic nephrectomy and renal transplant [1] Renal arteries are large vessels that arise from the aorta at right angles at the level of the intervertebral disc between the L1 and the L2 vertebrae [2]. At the hilum, renal vein is anterior to the renal artery which, is anterior to renal pelvis [3].

Renal artery variations are not uncommon and are generally grouped into the presence of accessory/aberrant renal arteries, polar arteries, and prehilar branching. Prehilar multiple branching of the main renal artery is a frequently seen variation reported to be present with an incidence of 11.66% [4].

Relatively common variations in the blood supply to the kidneys reflect the manner in which the blood supply continuously changes during fetal life [5].

Knowledge of vascular anatomy is important when undertaking partial nephrectomy for renal cell cancers.[6] Advanced imaging techniques have resulted in increasing use of minimally invasive approaches for nephron sparing surgeries of kidney. Consequently, study of normal and variant anatomy of vascular pedicle of kidney is justified [7].

MATERIALS AND METHODS

The hila and the adjacent pre-hilar area of 72 (35 right and 37 left) kidneys isolated from formalin fixed cadavers were examined. The hilum and prehilar area of each kidney was dissected to observe and note the total number of branches of the main renal artery prior to hilum Renal veins were reflected for proper visualization of branching pattern of renal arteries.

Fig. 1: Left Kidney showing one superior polar artery arising from main renal artery. SP- Superior polar artery, RA- renal artery, RV-renal vein P- pelvis of ureter.

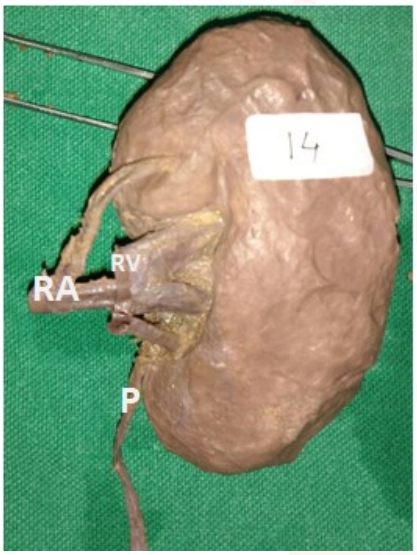


Fig. 2: Right kidney showing main renal artery giving 5 prehilar branches and one superior polar artery.

The arrangements of the structures in the renal hilum and prehilar area were analyzed. The division patterns of the renal arteries, before entering into the corresponding hilum were examined carefully and their relation to renal veins was documented.

The number of arterial branches and their percentage incidences were calculated in the right and left side as well as in the total number of kidneys.

The presence of polar arteries was observed and subsequently, their positions were examined. Percentage incidence of presence of superior and inferior polar arteries in right, left, and total number of kidneys was calculated.

Fig. 3: Anterior aspect of right kidney-Renal artery giving four prehilar branches posterior to renal vein and one superior polar artery. Renal vein reflected with pin

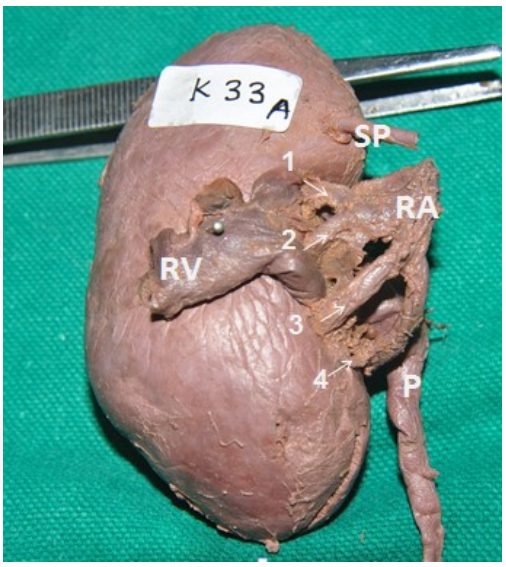
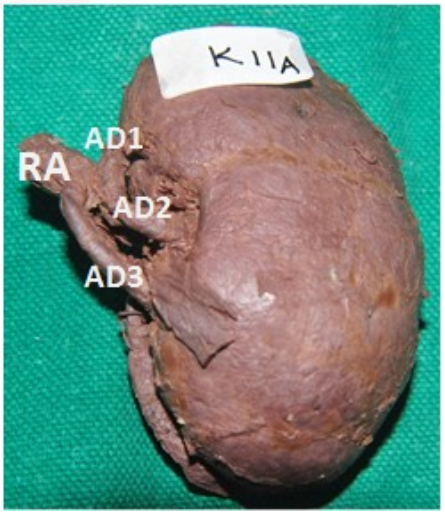


Fig. 4: Anterior aspect of left kidney- 3 branches of anterior division (AD) of renal artery entering hilum anterior to renal vein AD1, AD2, AD3.



RESULTS AND OBSERVATIONS

In 9 out of 72 kidneys, a separate polar artery was observed with an incidence of 12.5%. The superior polar artery was seen entering the renal parenchyma directly in 8/72 kidneys (5 right and 3 left) with incidence of 11.11%.Incidence in right kidneys was calculated 14.28% and in left kidneys incidence of 8.1% was observed.

The inferior polar artery was found in 1 left kidney with incidence of 2.7% in left and 1.38% of total kidneys. Incidence of superior and inferior polar arteries is presented in Table 1.

At the hilum, a single renal artery was observed in 18/37 (left) with incidence of 48.6% and 19/35(right) with incidence of 54.2 % i.e. total 37 out of 72 kidneys with total incidence of 51.3%

Prehilar branching of the renal artery was observed in 35 out of 72 kidneys with a total incidence of 48.6%. Prehilar branching of the renal artery was found in 16 out of 35 right kidneys with an incidence of 45.7% and 19 out of 37 left kidneys with an incidence of 51.3%.

The total number of branches of main renal artery in hilar and prehilar area and their percentage incidences is listed in Table 2.

The incidence of four branches of renal artery before entering the hilum was highest and was noted in 11.42% of right kidneys and 18.9% of left kidneys with a total incidence of 15.27%. A maximum of six branches of renal artery in prehilar region were observed in two left kidneys with total incidence of 2.7% and 5.4% incidence of left kidneys. It was found that out of 35 kidneys having two or more prehilar branches of renal artery, 17 kidneys showed all branches posterior to vein. This exhibits that no branches lay anterior to the vein, in (17/35) kidneys with incidence of 48.57%. Incidence in right sided kidneys was (9/16 = 56.25%) while in left kidneys, it was calculated as (8/19) = 42.10%.

Table 1: Incidence of superior and inferior polar arteries.

Presence of polar artery	No of right kidneys	Incidence in % In right kidneys	No of left kidneys	Incidence % In left kidneys	No of total kidneys	Total Incidence in %
Presence of superior polar artery	5	14.28	3	8.1	8	11.11
Presence of Inferior polar artery	0	0	1	2.7	1	1.38

Table 2: total branches of main renal artery with incidences observed.

No of arterial branches	No of right kidneys	Incidence in % in right kidneys	No of left kidneys	Incidence in % in right kidneys	No of total kidneys	Total Incidence in %
2	3	8.57	3	8.1	6	8.3
3	4	11.42	5	13.5	9	12.5
4	4	11.42	7	18.9	11	15.27
5	5	14.2	2	5.4	7	9.7
6	0	0	2	5.4	2	2.7

Table 3: shows number of prehilar arterial branches related anterior to renal vein and its tributaries when prehilar arterial branches of renal artery are two or greater than two.

No of prehilar branches of main renal artery	Total No of kidneys			No of kidneys having zero prehilar branches anterior to vein			No of kidneys having all prehilar branches anterior to vein			No of kidneys having half of the prehilar branches anterior to renal vein			No of kidneys having more than half of the branches anterior to renal vein			No of kidneys having less than half of the branches anterior to renal vein		
	R	L	T	R	L	T	R	L	T	R	L	T	R	L	T	R	L	T
2	3	3	6	3	3	6	0	0	0	0	0	0	0	0	0	0	0	0
3	6	3	9	3	1	4	0	1	1	0	0	0	0	2	2	1	1	2
4	4	7	11	2	3	5	0	0	0	0	3	3	1	1	2	1	0	1
5	6	1	7	1	1	2	0	0	0	0	0	0	2	1	3	2	0	2
6	0	2	2	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1

Where, R denotes Right, L denotes Left and T denotes Total.

As stated previously, prehilar branching of the renal artery was observed in total 35 out of 72 kidneys, i.e. 16 right 19 left kidneys. When prehilar branching of renal artery was observed, one left kidney out of 35 kidneys showed all branches anterior to renal vein with an incidence of 2.8% (incidence of presence of all prehilar branches of renal artery anterior to renal vein was 0% in right kidneys while in left kidneys it was 5.2%

When prehilar branching of renal artery was observed, 3 left kidneys showed half of the

branches anterior and half of the branches posterior to the vein with a total incidence of (3/35) 8.57%. In left kidneys, incidence was calculated to be 15.78% as compared to 0% in right kidneys. When prehilar branching of the renal artery was observed, the total number of kidneys having more than half of the branches anterior to vein was 8 out of 35 with an incidence of 22.85%. Subsequently, incidence in right kidneys was calculated to be 3/16, i.e. 3/16 = 18.75%, and incidence in left kidneys was 5/19 = 26.31%. When prehilar branching of renal artery was observed, total number of kidneys having less than half of the branches anterior to vein were 6/35 (4 right and 2 left) with incidence of 17.14% . Incidence in right kidneys was 4/16 = 25% and in left kidneys 2/19 was 10.52%.

DISCUSSION

Prehilar branching of the main renal artery before it enters the hilum was observed in 48.6% of kidneys with a higher incidence of 51.3% in left kidneys as compared with the incidence of the right side (45.7%).

At the hilum, a single renal artery was observed in 18/37 (left) with incidence of 48.6% and 19/35 (right) with an incidence of 54.2%, i.e. total 37 out of 72 kidneys having an incidence of 51.3%

In an earlier study, incidence of early branching of renal artery before it reached to the hilum of kidney was observed in 14/42 (33.3%) cases on the right side and 12/42 (28.5%) cases on the left side. Furthermore, single renal artery was observed in 18/42 (42.9%) on the right side and 20/42 (47.6%) on the left side [8].

The incidence of prehilar branching of renal artery was observed comparatively less than, i.e. 14% in another study [9].

Prehilar branches of renal artery correspond to segmental and pre-segmental arteries. Based on the observations by Weld et al, the pre-segmental artery was defined as a branch of the main renal artery that divided into two or more segmental arteries and the segmental artery was defined as a branch that enters the renal parenchyma [10]. It is important to emphasize that vascular segments are supplied by virtual end arteries. Knowledge of vascular anatomy is important when undertaking partial nephrectomy for renal cell cancers. In this surgery, branches of renal artery are defined so that the surgeon may safely excise the renal substance containing tumor whilst not compromising the vascular supply to the remaining renal tissue [7].

Clamping of the main renal artery is a commonly used technique to decrease intraoperative hemorrhage in partial nephrectomy. Renal vascular segmentation suggests that the selective clamping of a segmental renal artery can offer an improved surgical field and decrease the risk of warm ischemic injury to the whole kidney [11].

In our study, polar artery was observed in 12.5% cases. The superior polar artery was seen entering the renal parenchyma directly in 8/72 kidneys with an incidence of 11.11%. (5/35 right: 14.28% and 3/37 left: 8.1%). The inferior polar artery was found in one left kidney with an incidence of 2.7% of left kidneys. Superior polar renal artery was reported in 22.6% cases and was originating from main renal artery in 5.4% cases [12]. The superior polar artery is a segmental artery supplying the superior pole of the kidney. Its origin from the main renal artery as a prehilar branch is clinically important because inadvertent damage of this segmental artery during renal transplant surgeries will produce infarction of the superior segment of the kidney. Knowledge of such variations is also important for radiologists, anatomists and urologists [12].

During their “ascent” to the final site, the embryonic kidneys receive their blood supply from successively more superior vessels. In general, inferior vessels degenerate as superior ones take over. Failure of these vessels to degenerate result in accessory renal arteries, and some accessory renal arteries (polar) arteries enter the poles of the kidneys; consequently, these inferior polar arteries cross the ureter and may obstruct it. Variation in the number and position of these vessels occur in approximately 30% of the people [13].

Accessory renal arteries are end arteries. If such an aberrant artery is damaged or ligated, the part of the kidney supplied by it is likely to become ischemic [14]. As the renal arteries are end arteries, anastomosis must be made to all

the arteries of the donor kidney during kidney transplants [15].

The arrangements of renal vessels conform to the normal description (i.e. vein or tributaries of vein anterior to artery in hila of kidneys that have single renal artery or two branches of renal artery).

Variant patterns are more observed when renal artery gives three or more branches in the hilar region.

CONCLUSION

In this study, the main renal artery of 29 kidneys gave three or more branches in hilar and prehilar region. It was observed that in 18 out of 29 kidneys, renal arterial branches were the most anterior structures in the hilum with an incidence of 62% (18 out of 29 kidneys), i.e. if the renal artery in prehilar region gives three or more branches.

This knowledge assumes importance as nephron sparing surgeries such as partial nephrectomy by laparoscopic approach have become the treatment of choice. Such surgical interventions require hilar dissections, which are technically more challenging in laparoscopic approach as compared to open surgeries [11].

With the advent of laparoscopic renal surgeries, donor nephrectomies, renal transplantation and other retroperitonel surgeries, it becomes mandatory for the surgeons to thoroughly understand the variations in the renal vasculature [5].

Conflicts of Interests: **None**

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