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Morphological Study of Renal Vasculature in North India

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Abstract: The increasing use of invasive diagnostic and interventional procedures in daily life makes it important that the type and frequency of vascular variations are well documented and understood. With the advent of laparoscopic renal surgeries and transplants, it becomes mandatory for the surgeons to understand the abnormality or variations in the renal vasculature. Otherwise renal transplant may be endangered by the presence of aberrant vessels. Existence of the aberrant arteries is accountable in cases of renal pathologies, radiological interventions, renal transplants, and other surgical approach. The present study was performed on 20 cadavers over period of two years to observe the topographical anatomy of the renal vasculature. Out of 20 cadavers only one cadaver showed variations in renal vessels bilaterally. The right renal artery divided into two branches out of which the first trifurcate before entering into the hilum while the second entered directly at hilum. The right renal vein was formed by two tributaries. The left renal artery quadruplicate and left renal vein was formed by union of three tributaries.

Key words: kidney, renal artery, renal vein, accessory renal vessels

1. Introduction

The renal arteries are a pair of lateral branches arising from the abdominal aorta below the level of superior mesenteric artery at the upper lumbar level (L1-L3). The paired renal arteries take about 20% of the cardiac output to supply organs that represent less than one-hundredth of total body weight [1]. The right renal artery is longer in its course owing to the location of the abdominal aorta more towards the left side of midline. Each renal artery divides into anterior and posterior divisions at or very close to the hilum of the kidney. Further it divides into segmental arteries to supply the respective segments of the kidney being themselves the end arteries. Variation in the number, source, branching and course of the renal arteries are very common. These accessory renal arteries or the aberrant arteries account for about 30% of existence, while 70% owes for the normal type.

The large renal veins lie anterior to the renal arteries and open into the inferior vena cava almost at right angles. The left is three times longer than the right .The relative positions of the main hilar structures are the renal vein (anterior), the renal artery (intermediate) and the pelvis of the kidney (posterior).

In present study we observe the vascular pattern of 40 kidneys of 20 cadavers over a period of two years during the course of undergraduate medical teaching program in department of Anatomy. Out of 40 kidneys studied only one cadaver exhibit variations in both renal artery and vein bilaterally. Rest of kidneys showed normal pattern of renal artery and vein.

Observations

During two years of undergraduate medical teaching program we dissected 10 cadavers in each session. 15 female and 5 male cadavers age ranging from 40-85 years. We observed the abnormal vascular pattern in both kidneys of a 62 year male cadaver. The anomalous vasculature was studied in detail:

The right renal artery (RRA) originated from the abdominal aorta at level of second lumber vertebra, slightly at higher level than the left renal artery (LRA)[Fig-1]. RRA divided into two branches (1&2) [Fig.2] just behind the right renal vein (RRV). The second (2) branch entered the hilum of the kidney between upper tributary of RRV and ureter without any further division. The first (1) branch divided into three branches (a, b &c) run above the RRV. The

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superior branch further divided into two branches before entering into the upper part of hilum, while inferior branch run between two tributaries of renal vein to enter into the hilum.

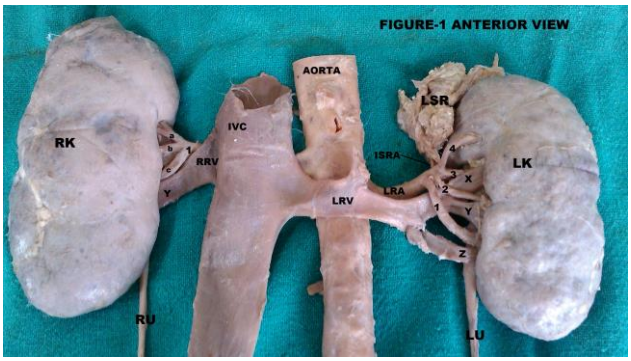

Figure 1: Anterior view -RK- Right Kidney, LK- Left Kidney, IVC- Inferior Vena Cava, RRA- Right Renal Artery, LRA -Left Renal Artery, RRV- Right Renal Vein, LRV- Left Renal Vein ISRA- Inferior Supra Renal Artery, LSR- Left Supra Renal Gland, RU- Right Ureter, LU- Left Ureter

There were two tributaries (X&Y) emerging out from the hilum joined together to form RRV.

The LRA after taking origin from aorta gave several branches before entering into the kidney. The first branch (1) course in front of LRV in between middle and inferior tributaries of LRV in a plane anterior to renal vein. The second branch (2) traversed the hilum between superior and middle tributaries of LRV in same plane of renal vein. The inferior supra renal artery (ISRA) arose just posterior to second branch. The (3) third branch entered at upper part of hilum behind the superior tributary of renal vein. The last branch (4) entered the kidney at upper pole.

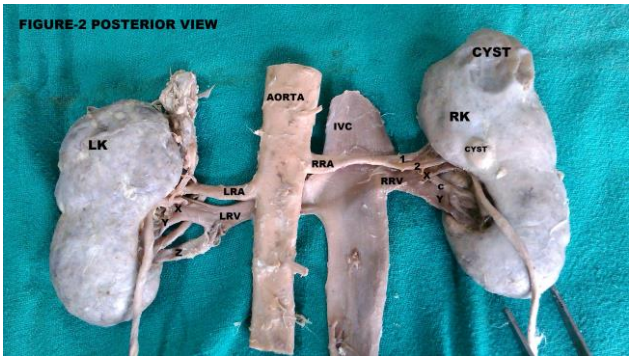

Figure 2: Posterior view-RK- Right Kidney, LK- Left Kidney, IVC- Inferior Vena Cava, RRA- Right Renal Artery, LRA -Left Renal Artery, RRV- Right Renal Vein, LRV- Left Renal Vein

The LRV formed by three tributaries emerging from hilum of kidney (X, Y and Z). X & Y joined together then it joined by Z to formed LRV.

In additional to above said variations both kidney had multiple cysts.

2. Discussion

Renal artery variations are divided into 2 groups: Early division and Extra renal artery (ERA). Branching of the main renal arteries into segmental branches more proximally than the renal hilus level is called early division. ERA is divided into 2 groups: hilar (accessory) and polar (aberrant) arteries. Hilar arteries enter kidneys from the hilus with the main renal artery, whereas polar arteries enter kidneys directly outside the hilus. Knowledge of the existence of aberrant renal arteries is important because they may be inadvertently damaged during renal surgery and their presence must be considered in evaluating a donor kidney for possible renal transplantation. Persistence of certain of the cephalic mesonephros arteries, however, may result in the arterial abnormalities.

Different origins of the renal arteries and its frequent variations are explained in various literatures owing to the development of mesonephric arteries. These mesonephric arteries extend from C6 to L3 during the development. Most cranial vessels disappear while the caudal arteries form a network, the rete arteriosum urogenitale that supplies in future the metanephros. The metanephros in future develops into adult kidney deriving its blood supply from the lowest suprarenal artery which gives out a permanent renal artery. Persistent roots of the network form these segmental arteries of the adult kidney having variations at their point of origin.

Regarding development of renal veins and inferior vena cava, it's already known that at first a pair of posterior cardinal veins (right and left) appear along the dorsolateral aspect of mesonephric ridge. On the ventromedial aspect of mesonephric ridge, a pair of subcardinal veins (right and left) develops which receive blood from the mesonephros and they establish a pre-aortic anastomosis between them. Subcardinal veins join with posterior cardinal veins both at the cephalic and caudal end. In addition several transverse communications develop dorsolateral to posterior cardinal veins. These veins join cranially and caudally with corresponding posterior cardinal veins. In addition the supra cardinal veins also anastomose with the subcardinal veins. Thus, inferior vena cava develops from the following the following:

i. Persistent caudal part of right posterior cardinal veins
ii. Right supra cardinal vein
iii. Anastomosis between right supra subcardinal veins which receives the right gonadal vein
iv. Upper part of right subcardinal vein which receives both renal veins
v. From communication between right subcardinal and common hepatic vein
vi. From common hepatic vein which is from suprahepatic part of right vitelline vein

Pick and Anson [2] reported bilateral extrahilar arteries in about 43% of cases. Harvey [3] reported the accessory renal artery from an origin below the origin of inferior mesenteric artery which passed markedly upwards to reach the kidney. Anson, Richardson and Meneiere [4] reported in their study that about half of the supernumerary vessels arising from the aorta enter the hilum while about half went to one or the other pole of the kidney. Merklin and Michaels [5] observed renal arteries vary in their level of origin (the right one often being superior), and in their calibre, obliquity and precise relation in almost 110000 kidneys. Fourman and Moffat [6] showed vascular pattern of

renal arteries. Schneider et al [7] observed each renal artery gives off one or more inferior suprarenal arteries and also branches to perinephric tissues in its extra renal course. Horacek et al [8] had given detailed accounts of renal arteries and its microvasculature. Subhra Mandal [9] et al reported bilateral additional renal arteries originating from abdominal aorta, an additional right renal vein and retro aortic left renal vein. Dhar [9] reported segmental branches or right renal artery sandwiched between the two right renal veins. Anomalous renal arteries arising from the aorta tend to be large ones but accessory renal arteries may also arise from the relatively small suprarenal or gonadal arteries, excluding ectopic kidneys to which the blood supply is frequently multiple and almost always anomalous in origin.

As already noted, multiple renal veins on the right side are not uncommon occurring in about a fourth of individuals. They tend to be less numerous than multiple renal arteries. Harvey [3] in a case report showed that both multiple renal arteries and veins bilaterally. However, the lowest veins from both sides were said to empty into a common trunk which passes down to the left common iliac veins, which may be the persistent caudal part of posterior cardinal vein that were interconnected by an oblique venous channel, persisting in adults as left common iliac vein. He also noticed two other veins emerging from left kidney, encircling the aorta which may be the persistent pre and post aortic anastomosis between two subcardinal veins. Pick and Anson [2] found multiple renal veins on the left side in only 1% cases. Dhar [9] reported emergence of two renal veins at the hilum of right kidney, which drained separately into inferior vena cava. Biswas and Chattopadhyay[9] reported a case with a variation in right renal and testicular veins, Senecail and Nonent [10] reported two rare anomalies of left renal vein, a circumaortic venous ring and a retroaortic bifid left renal vein.

Aberrant or accessory arteries have been of interest to the clinicians for some years, mainly because of the possible part the vessel may play in the causation of hydronephrosis. However, judging by the many descriptions of these vessels in the literature, it is evident that there is no established criterion for aberrance; the term has been applied equally to an additional artery in the renal pedicle, or to a vessel entering the kidney at either pole, whether derived from the main renal artery, from the aorta or from a branch of the aorta [11].

The kidney grafts with multiple arteries resulted in post-transplant morbidity and graft loss following the ligation of the polar arteries. The transplantation of the kidney with the single renal artery is technically easier compared to the kidney with multiple arteries.Gillespie, Miller and Baskin [12] found an anomalous vessel associated with hydronephrosis in 20 of 27 patients operated upon.

3. Conclusion

These anatomical variations are of immense importance because of its implications in various renal transplantation, renal surgeries & uroradiology. The knowledge of these variations could help the clinician in its recognition and protection. The unrecognized presence of polar vessels is a hazard in surgery. Fortunately, extra hilar veins are more easily damaged and less easily detected than extrahilar arteries which occur much less frequently than the latter. Apart from the danger of damage during surgical procedures, extrahilar or polar arteries can cause hydronephrosis resulting from obstruction of the ureter in the ureteropelvic region when the lower polar vessels pass in front of the ureter.

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