ANATOMIC VARIATION OF THE RENAL BLOOD SUPPLY (MAIN RENAL ARTERY AND ACCESSORY RENAL ARTERY) AND ITS EFFECT ON HUMAN HEALTH

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ABSTRACT

Information of the vascular anatomy of the kidney is important not only for Anatomist, Surgeons and medical doctors (cause of HTN) nonetheless also specifically to the surgeons to prevent surgical accidental injuries during partial nephrectomy, kidney transplantation, interventional radiological procedures, kidney surgeries and donor nephrectomies, urological and renal vascular operations more carefully and professionally. Specifically, an Inferior accessory renal artery located on the right side. This anatomical variation is the least common of all identified Reno vascular variants and has little previous documentation in existing literature. During the kidney surgery in the Nangarhar Regional hospital Jalalabad in the department of General surgery. We detected a variation in the vascular supply to the kidney on the right side of (18-20) years male Patients. We detected accessory renal artery to supply inferior segment of the right kidney and directly coming from abdominal aorta. Our current research was done in Nangarhar Reginal Hospital General Surgery Department from 2020-Jan to 2020-July.

INTRODUCTION

The kidneys are paired retroperitoneal organs that receive 20-25% of cardiac output and function in the filtration of blood and maintenance of fluid homeostasis. In the majority of the population, each kidney is perfused by a single renal artery that branches from the abdominal aorta at the level of the L1-2 vertebrae just a little under the origin of superior mesenteric artery. And enters the renal hilum. The left renal artery is usually little higher than right one, it passes posterior to left renal vein and then enters left kidney. Near the hilus of renal artery divides in to anterior and posterior partitions which intern divides in to different segmental arteries and supplies the respective segments of the kidney being they the end arteries [Saluja, S., Kumar, D., & Kalita, B. (2016)].

So, the presence of a single hilar renal artery has been shown to vary deeply in different studies, with prevalence ranging from 63-97%. In the remainder of these cases, the blood supply to the kidney includes accessory or aberrant renal arteries. Accessory renal arteries are auxiliary to the main renal artery and generally travel together with the renal artery through the hilus into the kidney. Alternatively, accessory renal arteries are the single source of kidney perfusion and typically branch directly from the abdominal aorta, entering the kidney outside of the hilum [Gray, H., Standring, S].

CASE REPORT

Amongst 60 Patients who admitted to Nangarhar Regional Hospital for kidney Stone Open Surgery, we observed 2 cases of the aberrant renal artery during the dissections of kidney form other adjacent structures, the patients were young (18-22years old), The flank pain was most often practiced during the later hours of the day, especially after ingestion of large quantities of fluid. They had been treated at OPDs in the past for urinary tract infection with right flank pain and weakness. Physical examination revealed blood pressure of 110/80 mmHg and the presence of costovertebral-angle tenderness. Urinalysis were within normal limits (WBC 0-1/HPF, RBC 0-1/HPF). Biochemical analysis revealed BUN level of 11.0 mg/dl and serum creatinine level of 0.8 mg/dl. Kidney ultra-sonogram showed a marked dilatation of the right pelvicalyceal system and right proximal ureter. Nevertheless, the left kidney showed normal appearance.

Excretory-urogram exposed a marked right hydronephrosis with dilated calyces due to ureteropelvic junction obstruction (Figure 1).

Figure.1

Excretory urogram after 35 mins. shows massive dilatation of the right pelvo-calyceal system with cortical thinning and smooth obstruction of the right ureteropelvic junction.

(Nangarhar Regional hospital Jalalabad Afghanistan, 2021)

The patient endured surgical exploration via an anterior approach which exposed a slightly ptotic, mobile, right kidney which was normal in size, with a marked hydronephrotic pelvis accessory renal artery and vein crossing the ureteropelvic junction, going on to the inferior pole and squeezing the ureteropelvic junction against the inferior pole of the kidney. The inferior segment was dissected carefully and taken photographs. Figure. 2

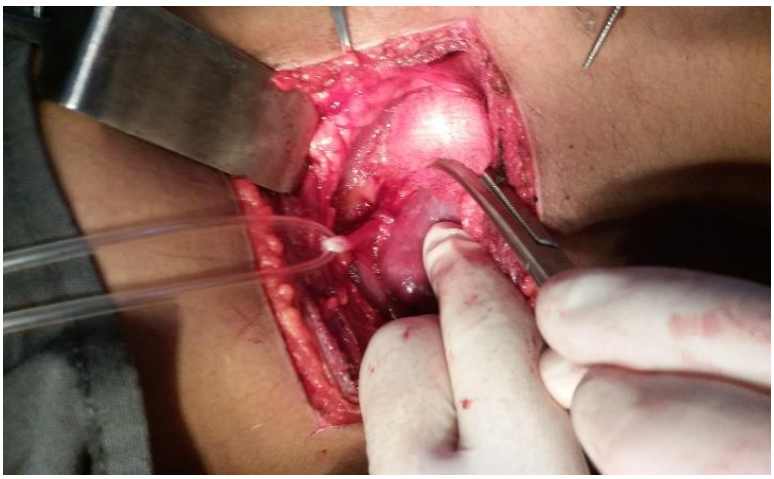

Fig. 2:

Inferior segmental artery, Ureter retracted by suction tube and inferior pole of the right kidney compress with the Gauze swab
(Nangarhar Regional hospital Jalalabad Afghanistan, 2021)

RESULTS

Left kidney:

Length- 9cm, width at upper part- 5cm, width at lower part- 3.5 cm, thickness- 2.8cm.

Main renal artery:

Originated from aorta just under the level of right kidney artery and it run towards the left kidney. It has separated in to superior and inferior branches 4cm from aorta 3cm from hilus.

Superior division has given branch to superior Segment and constant as artery for middle segment and supplies to it by dividing in to two lobar arteries 8mm from hilus.

Lower division run obliquely downwards and towards the inferior pole and supplied to the inferior segment by dividing in to second lobar arteries 15mm from the hilum.

Each renal artery gives off the following branches:

1. Inferior suprarenal, which ascends to the suprarenal body.
2. Capsular or peri-renal branches to the capsule of the kidney and peri-renal fat.
3. Ureteral branch to the upper end of the ureter.

Right kidney:

Length- 8.4cm, width at upper part-7.5cm, width at lower part- 3cm, thickness- 3 cm.

Right renal artery arises from aorta directly above the level of left renal artery, it has given lower anterior and upper posterior divisions 5cm from aorta. Lower Anterior branch run obliquely downwards and towards the hilus and 15mm from hilum divided in to middle and inferior segmental arteries and they have supplied to the respective segments. These arteries for middle and lower segments lie in front of the renal vein.

Upper anterior division arise from renal artery around 5.3cm from aorta, 3.6 cm from hilum and it divides in to apical and superior segmental arteries about 1.5 cm from hilum and supplied corresponding segments.

The continuation of right renal artery runs vertically down downwards along the hilum as posterior segmental artery and giving many lobar arteries along its course to the posterior segment.

Types of anomalies of the renal artery include:

Superior polar artery arising from the main renal artery.

1. Inferior polar and Superior polar artery from the aorta.
2. Inferior polar artery from the main renal artery.
3. Inferior polar arising from the common and internal iliac arteries. Furthermore, may ascend from the middle sacral or even inferior mesenteric arteries.

Accessory renal artery: It ascended from aorta just below and behind the main kidney artery and course to the right kidney just under and the main kidney artery near the kidney it has crossed the right ureter (just beneath the Pelvio-ureteric junction). It has given branch to the lower segment as Inferior renal polar artery about 3.1cm from the aorta and for supplying the lower segment and it is present in between pelvis of ureter lower part of the kidney. Figure : 3

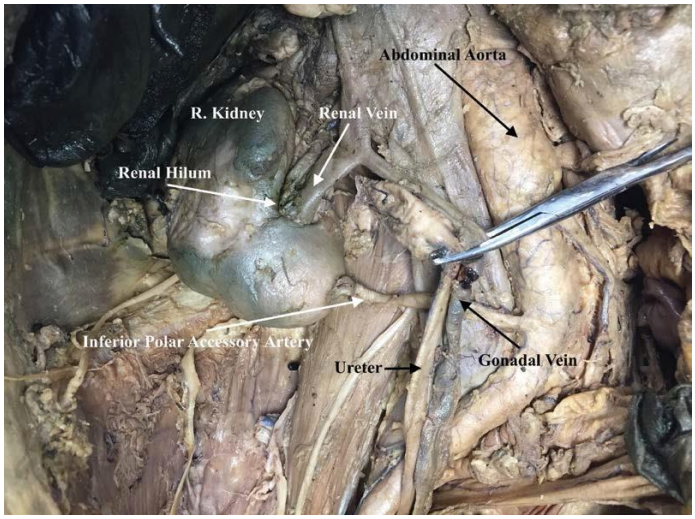

Fig: 3.

An image of the unilateral lower polar aberrant renal artery recognized in an 82-year-old female cadaver. The accessory renal artery branches of the abdominal aorta at the L4 spinal level just prior to the aortic divergence, and runs posterior to both the ureter and gonadal vein as it enters the inferior pole of the right kidney. Furthermore, the segmental branches of the primary kidney artery enter the kidney hilus Patel, K., Gandhi, S., & Modi, P. (2016)..

DISCUSSION

The kidney ascends and reaches the iliac fossa after crossing the pelvic edge, here it gets blood supply from common iliac arteries. Finally, it appears on the under surface of diaphragm where its ascent is arrested by adrenal gland which has in the meantime developed in this region. Here kidney receives the blood supply from lowest adrenal artery and this branch persist after birth as permanent renal artery. Aberrant renal artery is remnant of degenerated mesonephric artery [Datta AK (2013)].

Accessory renal arteries with an aortic derivation are frequent vascular variations, representing the persistence of the embryonic vessels, the lateral branches of the mesonephros, within the kidney ascent [*Larsen's human embryology,1996*] Fig: 2.

We discover the aberrant renal artery originated from the aorta just lower the origin of main renal artery.

Bremer states that the anomalies of the renal artery depend on vessels present in the embryo before the aorta and its larger branches develop mesodermal coats. There are no "late branches." certain anomalies are due to the persistence of the early kidney blood supply most frequently seen with pelvic kidneys, that is the renal artery as a branch of the iliac, inferior mesenteric or middle sacral.

Familiarity to the existence of aberrant renal arteries is important because they may be

Accidentally damaged during renal surgery and their presence must be considered in evaluating a donor kidney for renal transplantation. Persistence of certain of the cephalic mesonephros vessels, however, may result in the arterial abnormalities [Cerny JC, Karsch D 1973].

Simple division and ligation of accessory vessels causing hydronephrosis has cured the condition in the majority of cases reported. The Mayo Clinic in 1909 reported twenty-seven cases of surgically treated hydronephrosis. 20 of these were associated with aberrant blood vessels. In order to prove the causative

relationship, in 13 out of 20 cases the vessels were merely severed and ligated and a cure of the condition obtained. In 1922 Kummer collected fifty-six cases in which an operation (ligation) upon the aberrant obstructing arteries had cured the condition. In the author's case division and ligation of the accessory inferior polar artery causing hydronephrosis gave complete relief from symptoms (intermittent pain).

Quinby cautions against division of the larger accessory arteries to the kidney pointing out the danger of degeneration of that part of the kidney supplied by it, since there are no arterial anastomoses. Belt and Joelson have demonstrated by experimentation in dogs the degenerative process and scar formation in the kidney parenchyma happening to blockage of the blood supply. Kummer (cited by Belt) did not observe any evidence of necrosis of the kidney following the vascular section in fifty-six reported cases.

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 urogenital that supplies in future the metanephros. The metanephros in future develops into adult kidney deriving its blood supply from the lowest adrenal 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. 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 [Patel, K., Gandhi, S., & Modi, P. (2016)].

We suggested that the accessory renal artery ligation or damage during surgery will cause Segmental necrosis and Ischemia to supplied segment of kidney. Therefore during surgery of the kidney we must be careful for the variation of accessory renal artery from the different part of the other arteries.

The terminology of the variations of the renal arteries is still not clear as different authors described them as additional, accessory, hilar, inferior and superior polar arteries. We named our renal arteries as aberrant renal arteries [Shashikala, P, et all (2012)].

In research done by Bordei et al. found 54 double renal arteries mainly originating from the aorta in 272 kidneys (20%); six of them were bilateral (2,2%) and other was Unilateral [Shashikala, P, et all (2012)].

In last years, interest in the surgical and medical aspects of accessory renal arteries has been high because during renal surgical procedures, besides bleeding and loss of renal parenchyma, arterial lacerations may induce segmental ischemia followed by hypertension. The presence of accessory renal arteries increases the complexity of kidney transplantation; kidneys with accessory arterial supply being involved in a higher percentage of transplant failures than kidneys showing no variation [Shashikala, P, et all (2012)].

In study done by Satyapal et al. showed double renal arteries in 31.3% of the African population in their study, 30.9% of the white people, 18.5% of the half- case people and 13.5% of the Indian people[Bordei, P., Şapte, E., & Iliescu, D. (2004)]

There were early divisions in 67 (8%) patients, 32% of which occurred on the right side, 25% on the left, and 22% on the both sides [Satyapal, K. S, et all, (2001)].

We Detected 2 cases of aberrant renal artery in 60 patients suffering for renal surgery in Nangarhar regional hospital General surgery ward. Both was young and fit Patients and they suffer from history of intermittent Pain of right flank and also there was stones in the right kidney and with hydronephrosis.

Also reported double renal arteries, first renal artery arise from aorta at the level of L1 vertebra, whereas second renal artery arise from same 5.1 cm under the first one. Both renal artery run laterally and entered the kidney through the hilum with their anterior and posterior divisions. One branch (superior polar artery) of 1st renal artery arise from 0.5 cm away from main origin, course supero-laterally to reach the upper pole of the kidney and supplied it. Anterior division of 1st renal artery divided into four segmental arteries (1 apical, 1 upper, 2 middle) having intra renal course, while second renal artery give second segmental arteries (one middle and one lower). Posterior division of first renal artery gave second (apical) whereas that of second gave six (2 upper, 2 middle, 2 lower) segmental arteries [Özkan, U, et all, (2006)].

Had reported that the accessory right renal artery originated at the level of inferior border of L1 vertebra along with the origin of the normal right renal artery. This aberrant renal artery had a equivalent course with that of the right renal artery lying superior to it. The trunk of the Accessory renal artery entered the kidney from its anterior surface through its capsule giving off branch to the upper pole called superior polar artery. Additionally, this artery gave a posterior branch that was entering the capsule of the right kidney from its posterior surface almost close to its medial border behind the hilus. This Accessory artery gave a branch to the right adrenal gland, the inferior adrenal artery instead of the main renal artery supplying it. We also saw an extra-capsular branch given off by the main right renal artery to the anterior surface in front of the hilus [Shashikala, P, et all, (2012)].

Had reported that an uncommon variation of double left renal arteries one below the other. The upper left renal artery was higher wider than the lower left renal artery. The diameter of the left renal artery was smaller compared to the right renal artery. On the right side, the renal artery and vein were normal [Rao, T. R. (2011)].

Such a morphological appearance is important due to these branches being incorrectly interpreted as being additional arteries in diagnostic imaging studies and determines surgical complications in kidney transplants; since the first 15 mm of the kidney artery can be used for anastomosis with the receiver's iliac artery. It should also be emphasized that early ramification of the main renal artery and the presence of added arteries represent exclusion criteria in laparoscopic kidney surgery [Vishal, K., Vinay, K. V., & Remya, K. (2014), Holden, A, et all (200)].

Conferring to study by Gümüº H., et al. Kidney artery originating from the level of L1-L2 intervertebral disc was found in 37.0% and 38.9% of patients on the right and left sides, respectively. Kidney artery dissimilarities, including extra renal artery, were found in 27% and early division in 26.7% of the patients [Arora, A. et all, 2012].

The position of the kidney artery according to origin from abdominal aorta was assessed as origin of right kidney artery above the origin of left kidney artery 30 cases (60%), at the same level 14 cases (28%) and right kidney artery lower to left renal artery 6 cases (12%). So origin of Right kidney Artery is slight higher than Left kidney Artery in maximum cases [Gümüş, H et all (2012)].

Also the thought of systemic hypertension due to renal ischemia is well accepted. http://ahajournals.org by on June 25, 2021

CONCLUSION

A comprehensive knowledge of the anatomy and variation of the kidney arteries such as its origin, extent, caliber, number, course, branching patterns, structures present at hilus and their relations is very important to Clinical doctors to planning and performing procedure for safe attempt of kidney transplants, vascular reconstructions, while using non-angiographic, noninvasive methods for investigating kidney artery stenosis, the kidneys in trauma management and various surgical and radiological techniques Early division of kindey arteries may establish a danger in nephrectomy and in the partial resection of the kidney. The purpose of present Article is modest effort to bring awareness to the clinical doctors about the variation in the vascular pattern near its origin course and ramification at hilus for the safe and effective surgical procedures without vascular damage.

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