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Case Report

AN UNIQUE ASYMMETRICAL BILATERAL VARIATION OF RENAL ARTERY: RIGHT SIDED EARLY DIVISION AND LEFT SIDED ACCESSORY/ ADDITIONAL ARTERIES

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ABSTRACT

Variations in renal arteries are common due its complicated development, ascent and rotation. Estachius first described a case of multiple renal arteries in 1552. These arteries frequent at the inferior pole rather than the superior pole of kidneys. Additional renal arteries may or may not be associated with the congenital malformations of the kidneys. We report a unique asymmetrical bilateral variation of renal artery with right sided early division and left sided accessory/ additional arteries. It is not associated with any other anomaly of kidneys. All of these branches entered the kidney through the hilum. This ob-servation has clinical relevance for surgery, imaging, interven-tional radiological procedures as well as other diseases of kidney. Since renal arteries are end arteries; early branches and multiple arteries need to be attended individually during renal transplantation surgeries for better outcome.

KEYWORDS: Additional/accessory renal artery, Kidney, Renal artery.

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INTRODUCTION

The kidneys are retroperitoneal and they are located in the lumbar region, with the upper pole of the left kidney at the level of the T_{11}vertebra, whereas the upper pole of the right kidney lies at a lower level, at the level of the T_{11}-T_{12} intercostal space. Normally, renal arteries arise as lateral branches of abdominal aorta at the level of 2nd lumbar vertebra. They run laterally towards the kidney to enter the hilum between renal vein and renal pelvis. As it runs laterally it gives inferior suprarenal, ureteric and muscular branches [1].

Through the pronephric, mesonephric stages, definitive kidney develops from metanephros. During this period kidney ascends from pelvic cavity to subdiaphragmatic position. The hilum rotates from anterior to medial direction as it reach lumbar region. The foetal lobulations finally disappear. According to the observations which were made by Felix, there are nine pairs of arteries which supply the mesonephros, metanephros, gonads and the adrenal glands. These nine pairs have been divided into the cranial (the 1st and the 2nd pair), middle (the 3rd to the 5th pair) and the caudal (the 6th to the 9th pair) groups. The renal arteries develop from a single pair, from the middle group. The remaining arteries of the middle group, if they persist; give rise to the accessory or the aberrant

renal arteries. The renal artery which is single on each side at the renal sinus divides into segmental branches, which are end arteries. These persistent arteries may be associated with non ascent, incomplete ascent, an ectopic kidney, persistence of fetal lobulations or other congenital malformations [2].

The kidney transplantation is the commonest organ transplantation done in the present day modern surgery, which involves vascular reconstruction. Variations in the origin of the renal arteries and existence of accessory renal arteries are commonly reported. Although the occurrence of additional renal arteries displays a wide range between 8.7% and 75.7%, mostly it is reported that the average incidence of these arteries is approximately 30% and these arteries pass more to the inferior pole rather than the superior pole of kidneys [3].

MATERIALS AND METHODS

During routine undergraduate dissection, at Dept of Anatomy, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamilnadu the variation was noticed. A formalin-fixed male cadaver aged 60 years whose case history and cause of death is not known was dissected. Exposure of the kidney was done following classical incision and dissection procedures. The procedures followed were in accordance with ethical standards of handling of cadaver for learning and teaching.

RESULTS

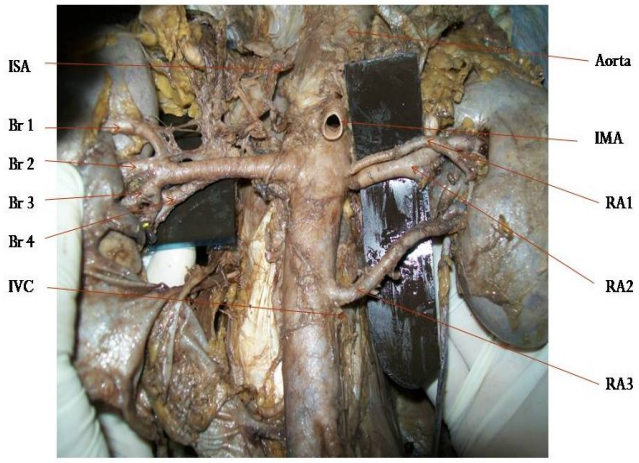
The inferior suprarenal artery and its relationship to the ureteropelvic junction is seen in this case; this condition is of considerable clinical importance. Polar or multiple renal arteries to a normally positioned kidney represents a failure of complete regression of all primary vascular channels. These multiple arteries may constrict infundibulum, major calyx or uretero pelvic junction. These arteries may pose altered haemo dynamics in renal physiology. (Fig 1 and 2)

DISCUSSION AND CONCLUSION

In the anatomy books the variations in the origin of the renal artery were divided into two groups. They were: (1) The early division and (2) The extra renal arteries. The early division consisted of the branching of the main renal arteries into segmental branches, which lay more proximal in terms of their origins. Extra Renal Arteries (ERA) Were Divided into 2 Groups: the hilar (also called as accessory) and the polar (also called as aberrant) arteries. The hilar arteries entered the kidneys from the hilus with the main renal artery, whereas the polar arteries entered the kidneys directly from the capsule outside the hilus [4].

Numerous anatomic variations regarding the vascularization of kidneys including presence of multiple arteries with or without congenitally abnormal kidneys, retroaortic course of the renal vein and abnormal origins of the renal arteries, have been reported in the literature.

Fig. 1: Renal Artery: Right Sided early division and left sided Accessory / Additional Arteries.



ISA- Inferior Suprarenal Artery, RA- Renal Artery, IMA- Inferior Mesenteric Artery, IVC- Inferior Vena Cava, Br- Branch of Renal Artery.

Fig. 2: Rt Kidney; Br- Branch of Renal Artery, RA- Renal Artery, IVC- Inferior Vena Cava.

Complex development of the kidneys through the 3 sets of excretory organs, pronephros, mesonephros and metanephros, and the ascent of the kidney from the pelvis to the lumbar region, along with its longitudinal rotation and simultaneous acquisition of a vascular supply, explain the common variations in the blood supply of kidneys associated with the congenital malformations. There is nonconformity in the literature regarding the nomenclature of renal arteries other than the main renal artery. They have been variously described as “accessory”, “aberrant”, “supernumerary”, “supplementary”, “multiple”, “accessory aortic hilar”, “aortic superior polar”, “aortic inferior polar” and “anomalous”. To facilitate accurate reporting of incidence of additional renal arteries. Satyapal et al made the following definition: An additional renal artery, other than the main renal artery, is one which arises from the aorta and terminates in the kidney [5].

In another study, the renal arterial supply was analyzed in 266 kidneys dissected from 133 fixed adult subjects. The anatomical findings included: 1 hilar artery in 53.3% of the cases, 1 hilar artery with 1 superior pole extra-hilar branch in 14.3%, 2 hilar arteries in 7.9%, 3 hilar arteries in 1.9%, superior polar artery in 6.8%, inferior polar artery in 5.3% and other variations in 8.5% [6,7].

Dissection of 40 cadavers studied by Dhar and Lal1has revealed a single main renal artery on either side in 80% of the specimens. Multiple (accessory) renal arteries in 20% of the specimens with unilateral anomaly (15%) being more ommonly encountered than bilateral anomaly (5%) [8].

A study of renal ascularization has reported 54 cases of double renal arteries supplying one kidney and originating from the aorta. Of the 54 cases, six cases were bilateral. In about 28 cases the supplementary renal artery ntered the kidney through the hilum, in 16 cases it was inferior polar, in 5 cases it was superior polar. Bordei et al. have reported 6 cases of retroureteral passage of the upplementary renal artery [9].

In a study conducted on 267 Thai adavers, following observations regarding renal artery were made: a single hilar artery in 82% of cases; double renal arteries in 17% of cases; and triple renal arteries occurred in 1% [10].

Accessory renal arteries are found frequently-more often on the left side and occurring in as high as 30-35% of cases in some series. These arteries usually enter the upper or lower poles of the kidney. In a case reported by Singh et al., the accessory renal arteries showed dual relationship with the ureters. Singh et al have reported a case of presence of bilateral accessory renal arteries which are giving origin to both the right and left gonadal arteries respectively [11].

In addition, many other individual cases of variations of the renal arteries have been reported [12, 32]. Some of them are listed below:

Author	Variation
Giavroglou and Kokkinakis [12]	supplementary left renal artery arising from the opposite renal artery
Loukas et al[13]	3 on the right side with one of them as a common trunk with the inferior mesenteric artery. 2 renal arteries on the left with left testicular artery as branch of one of them.
Bayramoglu et al [14]	Additional renal arteries originating from the abdominal aorta, passing posterior to ureter with a close relationship to the ureteropelvic junction.
Turgut et al [15]	2 polar arteries on the left idney besides the normal renal artery. The upper polar artery arising just at the beginning of left renal artery and the lower one arising directly from the lateral wall of abdominal aorta.

The frequencies of the multiple renal arteries ranged from 9%-76%, with an average occurrence rate of 28–30%, depending on the gender and the race. The cases of ectopic kidneys and uni-lateral or bilateral anomalous renal vessels have been reported in the literature regularly, with a frequency of 1:500 to 1:110. There are various levels at which the kidneys can stop ascending or they may ascend at a higher level than the normal. A single kidney was observed to be 1:1000, a single pelvic kidney was observed to be one in 22,000, a unilateral pelvic kidney with one normal kidney was observed to be 1:3000, a crossed renal ectopia was observed to be 1:7000 and a migration to the thoracic region, leading to a thoracic kidney was observed to be 1:13,000. 3 Most of the indi-viduals with ectopic kidneys are asymptomatic. They are identified during routine or unrelated investigations. Such cases are also as-sociated with multiple renal vessels [16, 17].

Any anomaly in the development of the renal arteries may delay the kidney migration, leading to ectopia and vice versa. In case of the renal

veins, the variations are associated with the development of the inferior vena cava [21, 22].

In our case, the additional renal vessels were retroureteral on both sides. However, we did not detect any pathology related to hydronephrosis. Even with the close retroureteral relationship of large additional renal vessels with the ureteropelvic junction on the right side,the general size of the calices and the renal pelvis appeared normal [23].

Imaging: The variations in the positions of the kidneys and the number of renal vessels and their positions are detected by a minimally invasive procedure, CT or CT angiography, to prevent damage to the renal vessels during renal or abdominal vascular surgeries. This helps in making an accurate diagnosis and in planning the right treatment [33].

Applied: The procedure of laparoscopic donor nephrectomy has gained popularity over the years and research studies have clearly spelt out the difficulty in carrying out such procedures in the presence of multiple renal arteries [34]. A study was conducted on the kidneys of donors, in which there were multiple renal arteries which were found to be 31% altogether; they were bilateral in 10.2% and unilateral in 20.8% cases [35]. It has been said that arteries in front of or behind the renal pelvis are the cause of ureteropelvic function obstruction in 15-52% of cases and their close relationship with the upper urinary tract can complicate the procedure of endopyelotomy [36].

Since the presence of renal vessels crossing posterior to the ureteropelvic junction influences the rate of hemorrhagic complications of endopyelotomy [37]. Knowledge of the variations of the anatomy of the blood supply of the kidneys is important in the surgical treatments such as renal transplantation, vascular reconstruction of both congenital and acquired lesions and abdominal aortic aneurysms [38, 39]. The role of additional renal vessels in the obstruction of ureteropelvic junction causing hydronephrosis remains controversial, and the retrouretral presence of the variant is more likely to be associated with ureteropelvic junctional obstruction [40, 41].

Polar or multiple renal arteries to a normally positioned kidney represents a failure of complete regression of all primary vascular channels. These multiple arteries may constrict infundibulum , major calyx or ureteropelvic junction. These arteries may pose altered haemodynamics in renal physiology. The evaluation of renal angiograms will be difficult unless you know these anatomical variations. More over renal arteries are functional end arteries, the ligation of which may lead to degeneration of that segment of kidney. However none of these variations in the vascular tree increases the kidneys susceptibility to diseases [1]. These multiple arteries complicate the kidney transplantation surgeries and may cause postoperative bleeding. The urologist must preserve each multiple arteries to save the renal segment since they are end arteries. So prior to surgical intervention renal angiogram is mandatory.

Familiarity about the possible variations in the renal arterial pattern is especially important for the personnel dealing with kidney retrieval and transplantation, various endourologic procedures and numerous interventional techniques. In such situations, it is the comprehensive knowledge of the renal arterial pattern which remains as the key issue in determining the technical feasibility of surgical interventions as well as the post operative management. In preparation for surgical interventions like, living renal donation, vascular reconstruction, renovascular hypertension, or radical nephrectomy, preoperative renal imaging is essential. In addition, the operative techniques with attention to the prehilar multiple branches of renal arteries should also be considered.

Our observations in the present case will supplement the knowledge of variations in the renal arteries, which should be quite useful in renal surgeries. Therefore, a sound knowledge of the multiple renal vessel variations and the renal ectopia are important for the urologists and the radiologists during the performance of renal surgeries in kidney donors and in kidney transplantations, especially in the laparoscopic surgeries which are done on kidneys. These variations should also be kept in mind when renal vessel surgeries are performed by vascular surgeons for renal artery stenosis or aneurisms.

Knowing the variations of large additional renal vessels located posteriorly to the ureteropelvic junction, as in our case, is very important.

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