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RENAL ARTERY VARIATIONS: A CADAVERIC STUDY WITH CLINICAL RELEVANCE

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ABSTRACT

Objectives: To observe and report the variations of renal artery in human cadavers. To compare the previous studies with the present study to report the incidence of the important type of variation.

Methods: The study was performed on 60 cadaveric kidneys. The posterior abdominal wall was dissected in 30 embalmed cadavers to study the paired kidneys based on the method given in Cunningham's manual of practical anatomy Vol II.

Results: The following parameters were observed. The number of renal arteries supplying each kidney, single in 73.33%, double in 23.33%, triple in 3.33%. The level of origin of renal arteries (RA), Right RA higher origin in 63.33%, Left RA higher origin in 10%, both right and left RA origin at same level in 26.7%. Branching of RA, Hilar in 88.33%, Prehilar in 11.67%. The prevalence of accessory renal arteries (ARA) in the present study is 25%. The percentage of unilateral ARA in the present study is 11.67% and of bilateral ARA is 6.67%. The percentage of arteries entering superior pole of the kidney, superior polar arteries (SPA) was 6.67%, inferior polar arteries(IPA) 10%, and hilar arteries(HA) 11.67%.. Percentage of origin of ARA from aorta is 20%, from main renal artery is 8.33%. Percentage of origin of SPA, IPA and HA from aorta is 3.33%, 8.33%, 8.33% and from main renal arteries is 2.33%, 1.67%, 2.33% respectively.

Conclusion: Anatomical knowledge of the vascular variations is essential for the clinician to perform procedures such as renal transplantation, renal vascular operations more safely and efficiently.

Keywords: renal artery, accessory renal artery, cadaver, variations, parameters

INTRODUCTION

Renal arteries are a pair of lateral branches 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 the organs that represent less than one hundredth of total body weight. A single renal artery to each kidney is present in approximately 70% of individuals. Near the renal hilum, each artery divides into an anterior and a posterior division and these divide into segmental arteries supplying the renal vascular segments. Accessory renal arteries are common (30% of individuals), and usually arise from the aorta above and below the main renal artery and follow it to the renal hilum. They are regarded as persistent embryonic lateral splanchnic arteries[1]. The frequency of accessory renal arteries show variability from 9%-76%. It is generally between 28%-30% in anatomic and cadaver studies. Variations or anomalies of veins are far more frequent than those of arteries, but this is not true of the vascular pedicle of the kidney-anomalous renal arteries are more

common than are anomalous renal veins[2]. Renal angiography, balloon angioplasty and stent implantation are now common diagnostic and therapeutic endovascular techniques in the treatment of renal artery pathology. For the successful implantation of the renal stent, precise knowledge of orientation of the origin of renal arteries from aorta is necessary. Multiple renal arteries have been associated with a higher rate of vascular complications, including arterial thrombosis and renal artery stenosis[3]. Variations in the renal artery have been the subject of repeated study, and a voluminous literature exists. The subject however is well worth of further study, not only from the morphological but also from surgical point of view. But most of the studies have been based on ultrasonography and angiography, and it has been that accessory renal arteries are detected with less frequently in angiographic studies[4]. Thus many workers, mainly surgeons have studied about the variations of renal arteries. This study was undertaken to observe and report the variations of renal arteries in humans, to compare the previous studies with the present study to report the incidence of important type of variation by cadaver dissection method.

MATERIALS AND METHODS

The study was conducted on 30 cadavers(60 kidneys) of both sexes during routine abdominal dissection for medical undergraduates, over a period of 3 years. Dissection was carried out to explore the vascular supply of kidney, along the length of abdominal aorta below the origin of superior mesenteric artery till its terminal bifurcation as common iliac arteries. Accessory renal arteries(ARA) were located and studied in detail and the specimens were photographed.

RESULTS

The following parameters were observed:

A) Regarding the number of renal arteries entering the kidney: 2 arteries in 14 specimens (23.33%), 3 arteries in 2 specimens (3.33%). Fig 1

B) Regarding the level of origin of renal arteries (RA): The origin of right RA higher than the left RA in 19 specimens (63.33%), left RA origin higher than the right in 3 specimens (10%), both right and left renal artery origin at the same level in 8 specimens(26.67%). Fig 1&3

C) Regarding the branching of renal arteries: Hilar branching in 53 specimens (88.33%) Fig 1, Prehilar branching in 7 specimens (11.67%)**.** Fig 3 right side

D) Regarding the presence of accessory renal artery(ARA): ARA was found in 15 specimens (25%), 8 specimens on the right side. Fig 1, 4 & 5, 7 specimens on the left side. Fig 3

E) Regarding the prevalence of unilaterality or bilaterality of accessory renal arteries (ARA): Unilateral in 7 specimens (11.67%) Fig 2, 4 & 5, Bilateral in 4 specimens (6.67%). Fig 1

F) Regarding the type of accessory renal arteries (ARA): Superior polar arteries (SPA) are 5(6.67%) Fig 1 left side, Inferior polar arteries(IPA) are 6(10%) Fig 2 & 3 left side, Hilar arteries are 7(11.67%)**.** Fig 4

G) Prevalence of type of accessory renal artery (ARA) on right side: superior polar arteries-1(3.33%), inferior polar A-2(6.67%), hilar arteries-4(13.33%). Prevalence of type of accessory renal artery (ARA) on left side: superior polar A-3(10%), inferior polar A-4(13.33%), hilar A-3(10%).

H) Source of origin of ARA: Aorta-12 out of 17(20%) Fig 1, 2 & 3, Main RA-5 out of 17(8.33%) Fig 4 & 5, none from the common iliac artery or the bifurcation of aorta**.**

I) Source of origin of different types of ARA: From Aorta-12, out of which 2 superior polar A, 5 inferior polar A, 5 hilar A. From Main Renal artery -5, out of which 2 Superior polar A, 1 Inferior polar A, 2 hilar artery.

DISSCUSSION

Knowledge of the variations of renal vascular anatomy has importance in exploration and treatment of renal trauma, renal transplantation, renovascular hypertension, renal artery embolisation, angioplasty or vascular reconstruction for congenital and acquired lesions[3]. Abnormalities of renal arteries are perhaps more frequently noted than any other of the larger arterial trunks[4].

The anomalies of accessory renal artery may be important from the clinical point of view in that they may cause a) hydronephrosis due to occlusion or compression of the ureter by an inferior polar artery, b) nephrotosis and malrotation of kidneys associated with an inferior polar artery, c) arterial hypertension because of constriction of renal artery and subsequent renal ischemia, d) the risk of infarction in a kidney during urologic or oncologic surgical interventions and renal transplantations. As the polar artery is a segmental artery, the erroneous ligation or division of it, is clearly hazardous resulting in necrosis of renal tissue[5].

Knowledge of the wide variation in the arterial supply of the kidney is of utmost surgical importance, for it causes one to appreciate the hazard of too forcible traction on the vascular pedicle which may occasion rupture of an anomalous vessel and fatal hemorrhage[6]. This statement pertains today especially since the definition of renal arterial anatomy impacts on renal transplant surgery, vascular operation for renal artery stenosis, reno-vascular hypertension, Takayasu's disease, renal trauma and uro-radiological procedures[7].

.Renal arteries are usually single, one renal artery supplying each kidney. The frequency of extrarenal arteries shows variability from 9% to 76% and is generally between 28-30% in anatomic and cadaver studies[8]. In our study, in 73.33% a single artery was found supplying the kidney, in 23.33% double renal artery, in 3.33% triple renal arteries. The results are similar to other studies (Table 1). The transplantation of kidney with the single artery is technically easier compared to the kidney with multiple arteries.

On comparing the number of renal arteries on right and left side the present study is more comparable with that of the study conducted by Kozielec (Table 2). The extra renal arteries are detected much less frequently than angiography, and the arteries entering the renal parenchyma are frequently confused with adrenal or capsular arteries. So it is important to consider the results obtained by cadaver dissection method when compared to those obtained by angiographic method.

Origin of right renal artery is usually higher than that of left. In our study, in 63.33% of specimens the right renal artery origin was at higher level, in 26.67% the origin of both right and left at the same level, in 10% the origin of left was at higher level (Table 3).

Branching of renal arteries into anterior and posterior divisions more proximal than the renal hilar level is called early division[9]. In present study, the division of renal artery was normal in 88.33% and early in 11.67%. This is comparable with the studies done by Kadir.S[8] and Ugur Ozkan[9].

Accessory renal arteries are common, and usually arise from aorta above or below the main renal artery and follow it to the renal hilum. They are regarded as persistent embryonic lateral splanchnic arteries[1] (Table 4), compares the prevalence of accessory renal arteries in our study with other studies.

The accessory renal arteries may be unilateral or bilateral. In our study the bilateral occurrence of accessory renal artery is 6.67%, and unilateral occurrence is 11.67% which is similar with the study by Dhar and Lal.(Unilateral-15%, Bilateral-5%).

The normal renal arteries enter the kidney through the hilum whereas the ARA may enter the kidney through the hilum other than its center or through the surfaces of the kidney. In our

study the accessory renal artery were classified as superior polar artery, inferior polar artery, and hilar artery and the prevalence of these types was compared with those of other studies. The inferior polar arteries are of extremely important in several clinical and surgical conditions, such as hydronephrosis. The inferior polar artery may obstruct upper part of ureter or the ureteropelvic junction causing hydronephrosis[1].

Accessory vessels to the inferior pole cross anterior to the ureter, and by obstructing the ureter may cause hydronephrosis[1]. As the polar artery is segmental artery, the erroneous ligation or division of it, is clearly hazardous resulting in necrosis of renal tissue[9]. Table 5 compares the studies noting the type of accessory renal arteries.

The present study was compared with other studies regarding the prevalence of origin of types of accessory arteries.

In our present study, out of 17 accessory renal arteries 12(20%) originated from aorta, whereas 5(8.33%) from the main renal artery.

With the advent of laparoscopic renal surgeries and donor nephrectomies, it becomes mandatory for the surgeon to understand the abnormality or variations in the renal vasculature. Otherwise renal transplant may be jeopardized by the presence of accessory renal vessels. Therefore, considering the increase in incidence of the accessory and multiple renal arteries, the anatomical knowledge of such may be important for the academic, surgical as well as radiological procedures and the present study is a humble effort to highlight the same.

CONCLUSION

The results of the present study were discussed and it clearly indicates that the renal artery shows frequent variations. Most of the variations were in the origin, branching and presence of accessory renal artery. The accessory renal artery also shows wide variations in numbers, origin, course and branching.

The knowledge of variations in renal arterial supply has wide clinical, surgical and academic implications. Familiarities about the possible variations are important to a surgeon dealing with kidney retrieval and transplantation, various endourological procedures and innumerable interventional techniques

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Table 1. Compares the present study with previous studies regarding the number of renal arteries entering the kidney

Authors	Single renal artery	Double renal arteries	Triple renal arteries
Per Odman(1968)[10]	75.9%	18.6%	5.4%
K.Khamanarong (2004)[11]	82%	17%	1%
Cicekcibasi(2005)[8]	75%	21.6%	3.3%
Present study(2010)	**73.33%**	**23.33%**	**3.33%**

Table 2. Compares the studies regarding the number of renal arteries on right and left side

Authors	Single renal artery		Double renal artery		Triple renal artery	
	Right	Left	Right	Left	Right	Left
Kozielec.T (1994)[12]	86.4%	69%	10.9%	25.5%	2.7%	5.5%
Ugur Ozkan (2006)[9]	83%	86%	15%	12%	1%	0.7%
Present study(2010)	**75%**	**71.4%**	**25%**	**21.43%**	**--**	**7.14%**

Table 3. Comparison of studies of level of origin of renal arteries on left and right sides

Author	Right higher	Both same level	Left higher
Kozielec.T(1994)[12]	32.7%	50.9%	2.7%
Cicekcibasi(2005)[3]	53.8%	34.6%	11.5%
Present study (2010)	**63.33%**	**26.67%**	**10%**

Table 4. Comparison of studies of prevalence of accessory renal arteries

Author	Percentage
Satyapal(2001)[7]	27.7%
Ronald(2003)[13]	17%
Avneesh Gupta(2004)[14]	24%
Ugur Ozkan (2006)[9]	24%
Srijit Das(2008)[15]	30-35%
Present study(2010)	**25%**

Table 5. Comparison of studies of type of accessory renal arteries

Authors	Superior pole	Inferior pole	Hilar
Rupert(1915)[4]	16%	9%	--
Bordei (2004)[16]	11.11%	29.62%	5%
Cicekcibasi(2005)[3]	3.33%	10.5%	11.1%
Present study(2010)	**6.67%**	**10%**	**11.67%**

FIGURES

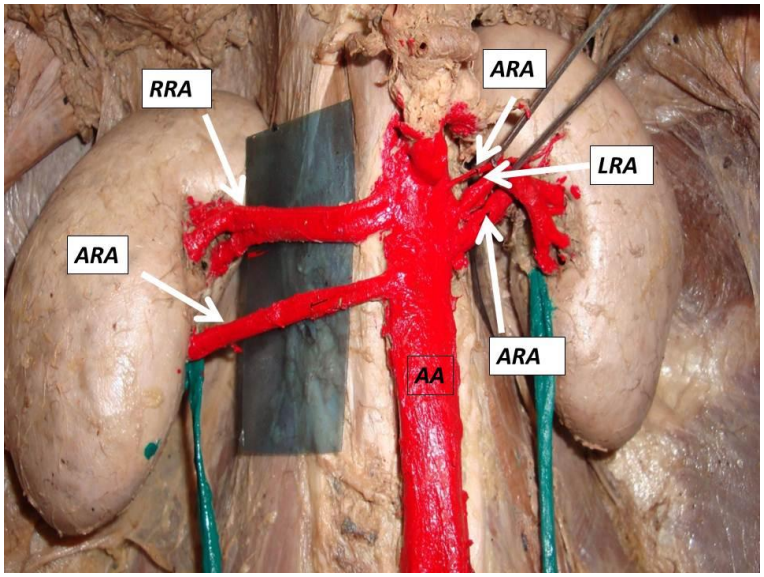

Figure- 1. Right Kidney with 2 renal arteries, RRA-Right renal artery, ARA-accessory renal artery entering the inferior pole. Left Kidney with 3 renal arteries, LRA-Left renal artery, ARA1 & ARA2-accessory renal arteries entering the superior pole.

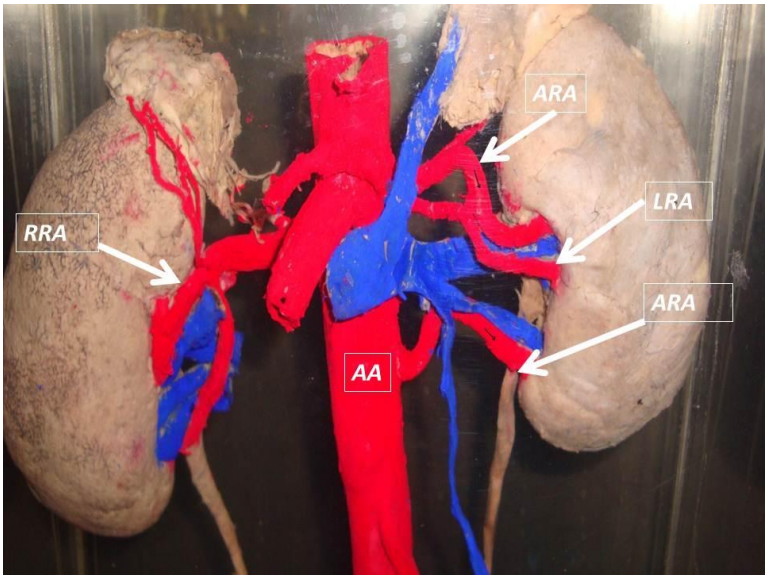

Figure-2. Left Kidney with 3 renal arteries, LRA-Left renal artery, ARA1 entering the hilum, ARA2 entering the inferior pole.

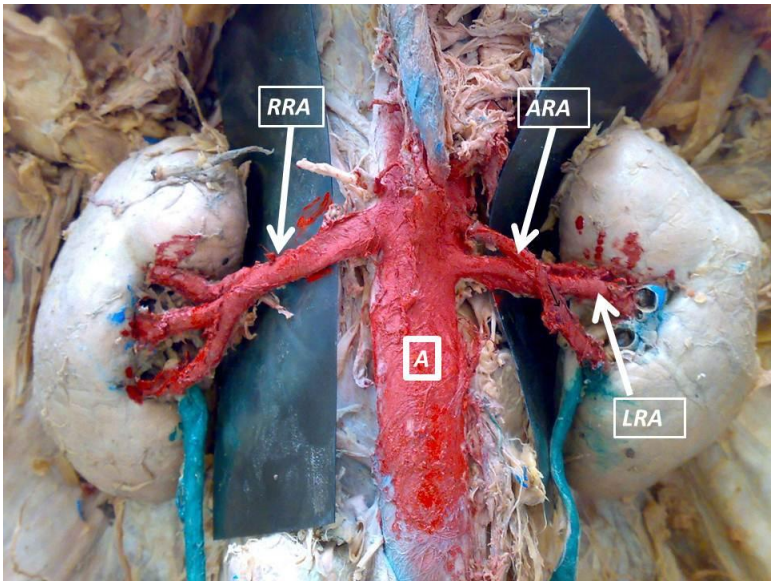

Figure-3.Right Kidney with prehilar branching of renal artery, Left Kidney with 2 renal arteries, LRA-Left renal artery, ARA-accessory renal arterycross LRA anteriorly and enter the inferior pole.

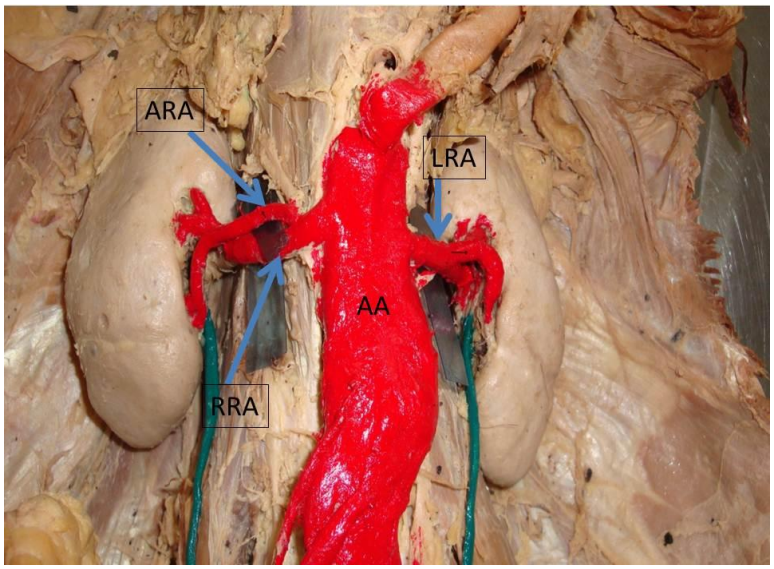

Figure-4. Right Kidney with 2 renal arteries, RRA-Right renal artery, ARA-accessory renal artery arising from RRA and entering the hilum. Left Kidney with 1 renal artery, LRA-Left renal artery show prehilar branching,

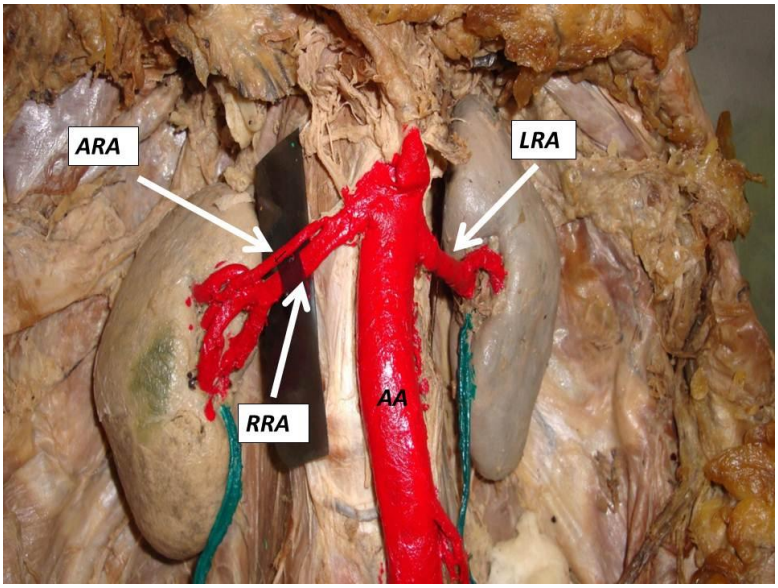

Figure-5. Right Kidney with 2 renal arteries, RRA-Right renal artery show prehilar branching, ARA-arising from main renal artery (RRA) and entering the hilum.