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Anatomical Variations of Renal Artery in Patients Undergoing Computerized Tomographic Scan in Sudan

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Abstract

Anatomical Variations of Renal Vascular in Patients Undergoing Computerized Tomographic scan in Sudan, the total number of patients studied is 400, 202 (50.5%) males and 198 (49.5%) females, and their ages ranged between (3 - 94) years. The study showed mean of total samples of the width and length of right and left kidneys respectively measurements were 5.354 ± 0.948 and 5.571 ± 0.966 for width and 10.028 ± 1.3684 and 10.060 ± 1.5203 for length, the width and length for right renal artery 5.746 ± 1.2814 and 5.881 ± 1.1444 respectively and for left renal artery 5.894 ± 1.3175 and 4.961 ± 1.3175 respectively. Accessory renal artery is a common but a significant anatomical variant of the renal vascular system, due to its clinical importance. In our sample, the accessory renal artery presence was detected in 6% and displayed a greater variation on the right than the left side. Because this abnormality plays an important role in kidney transplantations, in radiological, vascular and urological interventions, a detailed presentation of accessory renal artery incidence was conducted, gathering from the literature a large number of relevant studies in order to create a classification according to population, gender, side and specimen. And the study concluded that the renal arteries present a broad spectrum of variability in their morphological expression regarding their length, diameter and entrance to the kidney parenchyma. The inferior polar renal artery was found same as the superior polar renal artery, additional arteries' morphological expression was higher in men than women. This is statistically not significant and variation in the right side was found greater frequency than the left side.

Keywords

Renal Arteries, Computerized Tomographic Scan, Anatomical Variant, Renal Hilum

1. Introduction

Renal arteries are a pair of lateral branches from the abdominal aorta at the level of L1 - L2, little below the origin of the superior mesenteric artery. Each renal artery divides into an anterior and a posterior division near the hilum of the kidney, which in turn divides into five segmental arteries supplying the different renal vascular segments. Variations in the kidney arterial supply reflect the manner in which the vascular supply continually changes during embryonic and early fetal life. Accessory renal arteries usually arise from the abdominal 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]. Variations in the number, source and course of the renal arteries are common, most common variation being the accessory renal artery [2]. The frequency of accessory renal arteries varies from 9% to 76% with an average of 30%. In rare cases, accessory renal arteries may arise from the celiac trunk, superior mesenteric, inferior mesenteric, common iliac, middle sacral, or external iliac arteries [3].

In utero, the kidneys ascend from the pelvis to their final positions, with an evolving arterial supply during their migration. The persistence of fetal vessels results in variations in the numbers and origins of RAs. Knowledge of these features is vital for planning a range of endovascular and surgical procedures. The kidneys have vital physiologic functions such as hemofiltration and blood pressure regulation; therefore, any proposed treatment for RA disease may necessitate difficult management decisions in both elective and emergent settings.

While the use of catheter angiography as a diagnostic examination has declined, the role of endovascular therapy has evolved, and interventional radiologic techniques are often the treatment of choice for RA pathologic conditions.

Conventional angiography is the gold standard method to examine vascular structures; however, it is an invasive procedure and it is not adequate to determine renal vein variations in detail [4] [5]. Multidetector computed tomography (MDCT) is a highly sensitive method, allowing for the examination of the overall renal vascular anatomy along with arteries and veins together [6] [7].

Imaging of the RA and its branching patterns is mandatory before any renal operation. Preoperative imaging of the vascular variants facilitates the dissection of these vessels and helps to avoid vascular injuries [8]. MDCTA is a principal imaging investigation for assessment of the renal vasculature. It provides highly accurate and detailed evaluation of normal renal vascular anatomy and variants [9]. It was reported that the incidence of RA variations shows social, ethnic and racial differences [10]. Yammine [11] recommended the use of specific popula-

tion of interest in studying anatomical variations, rather than following generalized incidence rates as mentioned in textbooks. This encourages the shift towards evidence-based anatomy to insure safe medical practice. The aim of this study was to Anatomical Variations of Renal Vascular in Patients Undergoing Computed Tomography in Sudan.

2. Methodology

This is a retrospective hospital record-based study was performed in Sudanese population were the patients age ranged from 3 till 94 years (198 female and 202 males).

Study area and Population: Study area Khartoum state populations of this study were the patients who came to the radiology department suspect to have abdominal CT scan in Dar Al Elag hospitals and Ibn Sina hospitals in Khartoum state.

Sample technique and sample size: The sample size of this study was 400 patients (794 kidneys, as there are 6 patients with one kidney) from both gender with renal and with many other problems from 2 different hospital in Khartoum state. The sample was collected according to certain criteria.

Data collection: Data were collected by a carefully designed Data collection Form. The Data collection Form was designed for the purpose of this study. The Data collection Form was designed in English and it is filled by me and one well trained technician. It is consisted of four pages and was designed to be answered within fifteen minutes.

The first part consisted of participant's biographical data which was the name, gender, age, and the variables related to renal artery like state of the kidney, number, length, and width of the renal artery and type of accessory artery.

Materials:

CT Scan device: CT machine: CT Siemens Somatom Sensation 64, Siemens, Germany.

Method of renal artery identification:

After fasting 6 - 8 hours before examination and check patient history to deal with diabetic patient each patient ingested 800 ml of positive oral contrast, either a dilute barium suspension, or a 3% solution of gastrografin (sodium/meglumine diatrizoate. Schering) or similar water-soluble contrast which may be flavoured with fruit squash. The contrast is given 30 - 40 minutes before the scan to opacify the small bowel and a further 200 ml of the same contrast is given immediately before the scan to opacify the stomach and proximal small bowel. Intravenous contrast may be used to opacify the renal masses.

After drinking the oral contrast patient lying supine on couch first the topogram of the abdomen was scanned and then the selected region of interest from the upper margin of the Th12 vertebra to the symphysis pubis then we take the first run pre-IV contrast. Depend on patient weight we inject iv contrast media using 5 - 8 mm slice thickness with pitch of one- and 1.5-mm gap between each

slice. To detect renal artery in arterial phase we get the second run using bolus tracking technique with incidence peak 120 HU. After CT angiography images were processed by using various techniques, including multi planar reconstructions (MPR), maximum intensity projection (MIP) and volume rendering techniques (VRT) on the Advantage Windows 3D workstation. For arterial phase reconstruction the images were reconstructed at 1 mm slice thickness and 50% overlap.

The following parameters were evaluated:

The length of the main renal artery (from the ostium to branching), the diameter of the main renal artery at emergence from the aorta; the number of accessory arteries, if any; the presence of early branching; kidney length and width (**Figure 1**).

3. Results

The total number of patients studied is 400, 202 (50.5%) of which were males and 198 (49.5%) were females, and their ages ranged between (3 - 94) years (**Table 1**).

The Accessory renal arteries were detected in 6% (24/400) of the patients. In 3.0% (12/24), Accessory renal arteries were found on the right, in 1.8% (7/24) on the left side and in 1.3% (5/24) on the left and right (both) sides. In males, Accessory renal arteries were detected in 7.4% (15/202), 27% (4/15) on the left, 60% (9/15) on the right side and 13% (2/15) on the left and right side. In females, Accessory renal arteries were present in 4.5% (9/198), 33.3% (3/9) on the right and 33.3% (3/9) on the left side and 33.3% (3/9) on the left and right side (**Table 2**). The early divisions were detected in 5.3% (21/400) of the patients. In 1.0% (4/21), early divisions were found on the right, in 1.8% (7/21) on the left side and in 2.5% (10/21) on the left and right sides (**Table 3**). In males, early divisions were detected in 5% (10/202), (3/10) on the left, (1/10) on the right side and (6/10) on the left and right side. In females, early divisions were present in 6% (11/198), (3/11) on the right and (4/11) on the left side and (4/11) on the left and right side (**Table 3**). There were 0.75% (3/400) patients without right kidney and 0.75% (3/400) patients without left kidney (**Table 4**). The study showed mean of total samples of the width and length of right and left kidneys respectively measurements were 5.354 ± 0.948 and 5.571 ± 0.966 for width and 10.028 ± 1.3684 and 10.060 ± 1.5203 for length, the width and length for right renal artery 5.746 ± 1.2814 and 5.881 ± 1.1444 respectively and for left renal artery 5.894 ± 1.3175 and 4.961 ± 1.0294 respectively, in **Table 5**. There was no statistically significant difference was found between gender and variables ($p > 0.05$) (**Table 6** and **Table 7**). 50.5% males 202 and 49.5% females 198 total of patients 400. The percentage of males and females are almost equal. The accessory renal artery was more in male than female and the right accessory is almost twice than the left and more than twice of the left and right. The Early Division Renal Artery on the left and right was more than left and right.

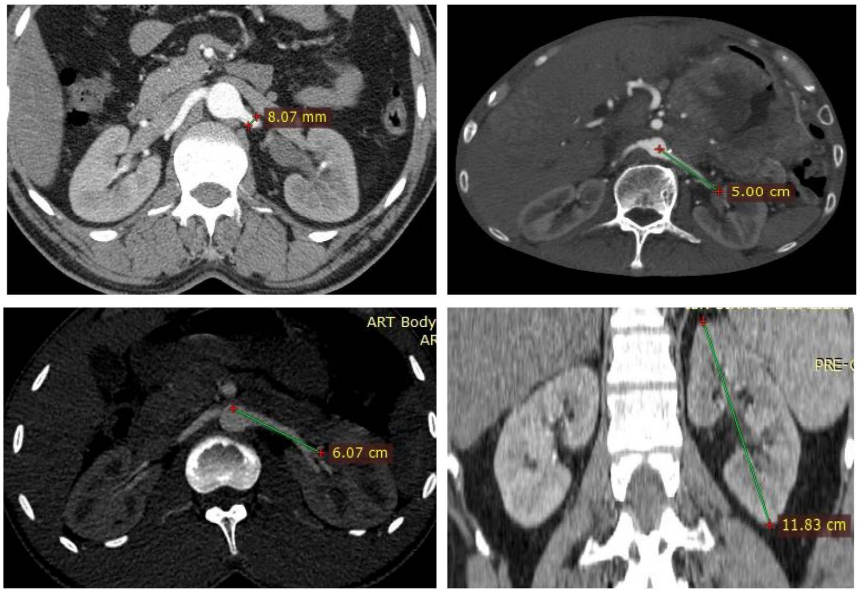

Figure 1. Method of Measurements of kidney and renal artery.

Table 1. Frequency distribution for gender.

GENDER	Frequency	Percent
Female	198	49.5
Male	202	50.5
Total	400	100.0

Table 2. Crosstabulation between the gender with the side of accessory renal artery.

GENDER	Accessory Renal Artery			Total
	left	Right	Left and right	
Female	3	3	3	9
Male	4	9	2	15
Total	7	12	5	24

Table 3. Crosstabulation between patients' gender and side of Early Division Renal Artery.

GENDER	Early Division Renal Artery			Total
	Left	Right	Left and right	
Female	4	3	4	11
Male	3	1	6	10
Total	7	4	10	21

The patients that have one kidney almost have disease.

The frequency of renal disease was represented the highest percentage.

Table 4. Crosstabulation between absence of kidney and history.

Left kidney			Right kidney		
History	Freq.	Percent	History	Freq.	Percent
Hypertension	1	33.3	None	1	33.3
Renal Disease	2	66.7	Renal Disease	2	66.7
Total	3	100.0	Total	3	100.0

Table 5. Show statistical parameters for all patients.

Variables	Mean	Std. Dev	Minimum	Maximum
Width of Right Renal Artery	5.777	1.1803	2.0	10.0
Length of Right Renal Artery	5.929	1.0289	2.2	10.0
Width of Right Kidney	5.385	0.8217	3.3	9.0
Length of Right Kidney	10.090	1.0490	6.5	12.7
Width of Left Renal Artery	5.940	1.2176	0.0	10.0
Length of Left Renal Artery	4.999	0.9411	0.0	9.3
Width of Left Kidney	5.614	0.8420	3.5	9.6
Length of Left Kidney	10.138	1.2517	5.2	15.0

Table 6. Analysis of variance between the patients age with other variables.

		Sum of Squares	df	Mean Square	F	p. value
Width of Right Renal Artery	Between Groups	122.534	77	1.591	0.962	0.570
	Within Groups	532.598	322	1.654		
	Total	655.133	399			
Length of Right Renal Artery	Between Groups	115.805	77	1.504	1.190	0.153
	Within Groups	406.791	322	1.263		
	Total	522.596	399			
Width of Right Kidney	Between Groups	55.613	77	0.722	0.766	0.920
	Within Groups	303.461	322	0.942		
	Total	359.074	399			
Length of Right Kidney	Between Groups	96.922	77	1.259	0.623	0.993
	Within Groups	650.208	322	2.019		
	Total	747.131	399			
Width of Left Renal Artery	Between Groups	139.399	77	1.810	1.054	0.371
	Within Groups	553.144	322	1.718		
	Total	692.543	399			

Continued

Length of Left Renal Artery	Between Groups	82.886	77	1.076	1.020	0.442
	Within Groups	339.941	322	1.056		
	Total	422.827	399			
Width of Left Kidney	Between Groups	75.479	77	0.980	1.061	0.356
	Within Groups	297.489	322	0.924		
	Total	372.968	399			
Length of Left Kidney	Between Groups	160.755	77	2.088	0.883	0.741
	Within Groups	761.427	322	2.365		
	Total	922.182	399			

Table 7. Crosstabulation between the history with gender.

History	Gender		Total
	Female	Male	
None	74	74	148
Hypertension	15	18	33
Congenital Heart diseases	2	1	3
Renal disease	33	36	69
Diabetic	34	19	53
Vascular disease	12	10	22
Hypertension & Congenital Heart diseases	6	14	20
diabetic & vascular disease	12	18	30
Renal disease & diabetic	10	12	22
Total	Total	202	400

4. Discussion

The total number of patients studied is 400, 202 (50.5%) of which were males and 198 (49.5%) were females, and their ages ranged between (3 - 94) years. The study showed mean of total samples of the width and length of right and left kidneys respectively measurements were 5.354 ± 0.948 and 5.571 ± 0.966 for width and 10.028 ± 1.3684 and 10.060 ± 1.5203 for length, the width and length for right renal artery 5.746 ± 1.2814 and 5.881 ± 1.1444 respectively and for left renal artery 5.894 ± 1.3175 and 4.961 ± 1.3175 respectively.

In many studies, the sample was dissected cadavers or specimens from an autopsy, while in other angiographic studies, the sample was patients. It is argued that the cadaver dissection probably affords a more accurate determination of the number of renal arteries, than aortography [12]. In angiographic studies, the MRA were detected less frequently due to their thickness (diameter > 2 mm).

Particularly when the MRA originated from AA, they are not detecatable and the arteries entering the kidney outside the hilum are frequently confused with the adrenal or capsular arteries [13]. Computed tomography angiography is an effective method for evaluating the renovascular morphology of the donor [14]. CT is an excellent imaging method to evaluate the normal anatomy of renal vascular structures, as well as its variations. The number and course of the renal artery and renal veins could easily and precisely define by performing a CT angiography [7]. It is noteworthy that the magnetic resonance angiography failed to predict the anatomy of renal arteries in 10% of the patients with MRA compared to angiography, in which the relative incidence was 3% [15].

Furthermore, there is a great controversy about the Multiple Renal Artery (MRA) incidence according to side; Some investigators reported that MRA are frequently left-sided, while others contradict that the right side predominates, and it has also been reported that there is no significant difference regarding additional arteries' presentation side [16]. However, Wondmagegn, *et al.*, found that there is no significant difference was noted in the overall outcome of transplantation of renal allografts with and without vascular variations. Hence, renal allografts with vascular variations are safe to be recruited for transplantation [17].

5. Conclusions

Anatomical Variations of Renal Vascular in Patients Undergoing Computerized Tomographic scan in Sudan, the total number of patients studied is 400, 202 (50.5%) males and 198 (49.5%) females, and their ages ranged between (3 - 94) years.

Accessory renal artery is a common but a significant anatomical variant of the renal vascular system, due to its clinical importance. In our sample, the accessory renal artery presence was detected in 6% and displayed a greater variation on the right than the left side. Because this abnormality plays an important role in kidney transplantations, in radiological, vascular and urological interventions, a detailed presentation of accessory renal artery incidence was conducted, gathering from the literature a large number of relevant studies in order to create a classification according to population, gender, side and specimen. And the study concluded that the renal arteries present a broad spectrum of variability in their morphological expression regarding their length, diameter and entrance to the kidney parenchyma.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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