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ANATOMICAL VARIANTS OF RENAL VASCULATURE: A STUDY IN ADULTS ON MULTIDETECTOR COMPUTERIZED TOMOGRAPHY ANGIOGRAPHY SCAN.

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ABSTRACT… Objectives: To determine renal artery variation in adults in a subset of Karachi population by using Multidetector Computed Tomography (MDCT) angiography. **Study Design:** A cross sectional study. **Setting:** Dr. Ziauddin Hospital, Radiology Department, Karachi. **Period:** From January, 2017 to June, 2017. **Material & Methods:** Study participants were 250 individuals, who were presented to Dr. Ziauddin hospital, Karachi, Distribution, number and morphology of renal artery variation were reported on Multidetector computed angiography (MDCTA). Renal artery variation with side of the kidney and gender were analyzed. Data was analyzed on SPSS version 20 (Statistical Package for Social Sciences). Frequencies and percentages were calculated for renal artery variations. **Results:** Following parameters were observed. Out of total 250 study participants single renal artery was present in 73.6 % (184) individuals and accessory renal artery was present in 26.4% (66) individuals. Accessory renal arteries (ARA) were present in 13.8% (35) individuals and 12.6% (31) individuals on respectively on right and left sides. Among accessory renal arteries superior polar arteries were present in 14.9% (37) kidneys, hilar arteries in 10.2 % (26) kidneys and inferior polar arteries in 1.3 % (3) kidney. **Conclusion:** A complete knowledge of renal artery variations is essential for surgeons and interventional radiologist especially during procedures such as renal vascular interventions and renal transplant. Frequency of ARA in our studied population is comparable to Asian population.

Key words: Accessory Renal Artery, Computed Tomography, Renal Artery.

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INTRODUCTION

Kidney diseases are rapidly increasingly South Asian countries in Pakistan. Prevalence of chronic renal disease in Pakistan is estimated to be 12.5%.[1] This increasing prevalence is mainly due to diabetes nephropathy (28%), chronic glomerulonephritis (22%) followed by hypertention (14.6%).[2] In spite of having a huge burden of kidney diseases, there is a dearth of normal data on renal vascular anatomy in Pakistani population.[2,3] For kidney failure, kidney transplant is the best choice of treatment modality which gives a good long-term quality of life. Therefore it's extremely necessary for a living donor to avoid complications during surgery, should have a complete renal vasculature evaluation.[4] Renal artery variations have gained significance in the last decades because of the pervasive development in interventional radiological procedures and transplantation surgeries.[5] A study reported, that persons with kidneys having extra renal arteries appear to have higher incidence of renovascular hypertension.[6]

Renal arteries supplying kidneys, are paired branches of abdominal aorta.[7] Incidence of a single main renal artery is 70% in individuals. However, accessory renal arteries (ARA) are present in 30% of individuals.[7-9] ARA are the most important variation of the renal circulatory system, come across in around one third of anatomic dissection.[10] Accessory renal arteries commonly arises from abdominal aorta, but they may arise from the celiac or superior mesenteric arteries and even from common iliac arteries.[8] Accessory renal arteries (ARA) are classified as polar and hilar arteries. Hilar artery enters at the renal hilum along with main renal artery, whereas polar artery

enters the kidney at one of its poles through its surface outside the hilum.[11]

Accessory renal arteries are regarded as persistent embryonic lateral splanchnic arteries. Extra renal arteries are vestigial structures that develop due to failure to degenerate, during ascent of primordial permanent kidney (metanephros).[12] In developing human embryo, permanent kidney which is metanephros ascends from pelvic cavity to abdomen. During its ascent it receives blood vessels close to it. Initially renal arteries are branches of common iliac arteries, later on, they arise from distal end of aorta. When they are located at higher level, they receive new branches from aorta and older vessels degenerate until a single persistent renal artery forms.[13]

Catheter angiography which was usually used to visualize arteries, is regarded as a gold standard technique, however its invasive nature decreases its use. However, an important development in computerized tomography (CT) imaging is, Multidetector computed tomography (MDCT) angiography.[10,14] MDCT is less invasive, accurate, have high speed acquisition, and provides multiple 3D reconstructed images to visualize renal arterial anatomy and renal parenchyma.[15]

Due to increasing laparoscopic renal surgeries, donor nephrectomies and endovascular interventions like aneurysmal repair or graft deployment, it is important to have a complete detail knowledge of variations in the renal vasculature.[11,16,17]

Incidence of accessory renal artery is reported to vary in different populations. Different studies have been performed, to determine frequency of accessory renal arteries. However, most of them were on cadavers. To the best of our knowledge there is no specific data in our population was available. Therefore, this study was done to determine the incidence of accessory renal arteries in our Pakistani population.

MATERIAL AND METHODS

Setting

Study participants were recruited from Radiology Department of Dr. Ziauddin University Hospital, Karachi.

Target Population

The total number of 250 individuals of 21 years to 60 years of age, with no renal disease and no renal vascular disease were included in the study.

Sampling Technique

Non probability consecutive sampling was done.

Inclusion Criteria

Individuals with serum creatinine (S.Cr) ≤ 1.3 mg /dl.

Exclusion Criteria

Patients with a history of kidney transplant, congenital renal anomaly, vasculitis, hypertension and diabetes mellitus.

Radiological Assessment

CT examinations were performed after intravenous contrast administration on a MDCT scanner (16-slicer) in arterial phase. A standard protocol of CT scan was followed,[10,18] on a 16-slice MDCT scanner.[19] Contrast material was given at the rate of 4 ml/second and the patient was instructed to hold his/her breath for 10 seconds and scan was initiated. After a 10 to 15 seconds set delay of the of the contrast agent, acquisition of image data was started. Then, image volumetric data was transferred to a workstation, to post-process volumetric MDCT data. Then computer software was used to post process and three dimensional reconstructions of images in different projections in arterial phase of scan. Maximum intensity projection (MIP) images oblique, coronal and sagittal images were used to visualize renal artery.

STATISTICAL ANALYSIS

Data was entered and analyzed on SPSS version 20. Frequencies and percentages were calculated for qualitative variables. Frequency of accessory renal arteries on both sides and between genders was compared by Chi-square. Confidence level was taken at 95% and P-value was ≤ 0.05 was considered significant. Total sample size of 250 individuals (500 kidneys) was calculated by using

WHO sample size calculator keeping prevalence at 27 %.[20] Confidence level 95% and bound of error at 6%.

RESULTS

The mean age of study participants was 43.9 ± 11.8 years, ranging from 21 to 60 years. Out of total 250 study participants, 52 % (129 out of 250) were males and 48 % (121 out of 250) were females. The mean age was 43.5 ± 11.0 and 44.3 ± 12.6 years of males and females respectively.

In study sample single out off total 250 individuals, renal artery was present in 73.6 % (184) and accessory renal artery was present in 26.4% (66) individuals (Figure-3). All accessory renal arteries took origin from abdominal aorta. Accessory renal arteries (ARA) were present in 13.8% (35) individuals on the right side and 12.6% (31) individuals on the left side. ARA was found more in males 14.4% (36) than females 12.2% (30).

Among accessory renal arteries, superior polar arteries were present in 14.9% (37) kidneys, hilar arteries in 10.2 % (26) kidneys and inferior polar arteries in 1.3 % (3) kidneys (Figure-1,2 and 4).

Figure 1: Three dimensional MPR (multiplanar reconstructed) image showing right superior polar accessory renal artery during study.

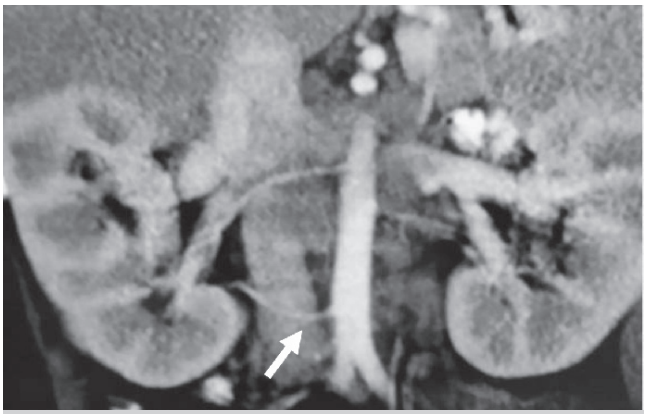

Figure-2. Three dimensional MIP (maximum intensity projection) image showing right inferior polar accessory renal artery during study.

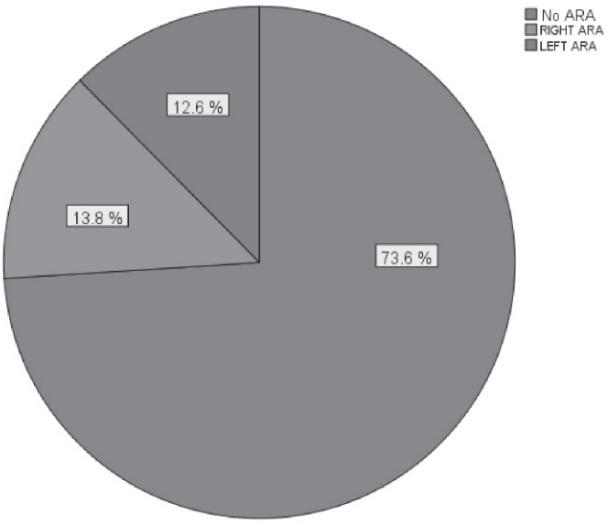

Figure-3. Pie chart showing the frequency of accessory renal artery (ARA) on right side and left side.

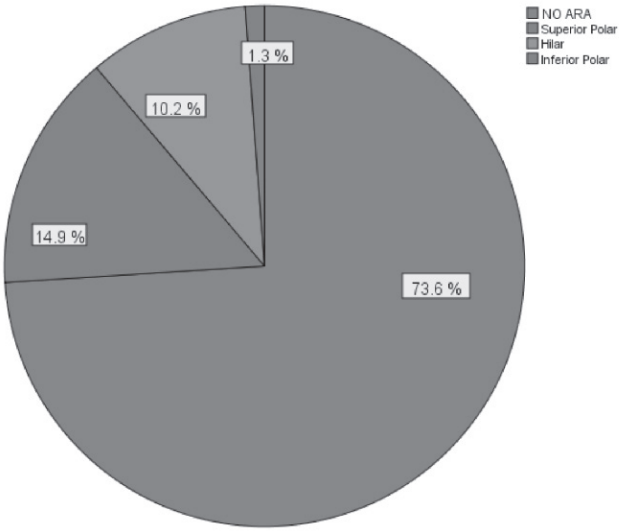

Figure-4. Pie chart showing the frequency of different types of accessory renal arteries.

DISCUSSION

Occurrence of accessory renal arteries (ARA) is one of the most common variation of renal arterial anatomy.[11] Knowledge of distribution of accessory renal arteries is imperative because a donor kidney with accessory renal artery is not preferred for transplant surgery. According to Breno Jose et al, "multiple renal arteries have no anastomosis between themselves and thus they are considered to be end arteries".[18] Therefore, awareness about ARA is extremely important as their mistaken ligation or division leads to renal ischemia and reduced function of grafted kidney. If inferior polar artery may obstruct upper part of ureter or ureteropelvic junction and can lead to obstructive hydronephrosis. Section of an inferior polar artery may also cause pyeloureteral necrosis of the graft leading to stenosis or urinary tract leakage.[21]

Frequency of accessory renal artery found in our study was found to be 26.4 % (n = 66). On the right side frequency of ARA was present in 13.8 % (n = 35) individuals and on left side it was found in 12.6 % (n = 31) individuals. Different studies reported frequency of accessory renal arteries in different populations. Incidence of ARA found in our studied population was comparable with studies conducted in Turkey 27 %[22], Iran 24.8 %[23], India 24%[24], Brazil 23 %[25] and America 27.7 %.[26]

In our study frequency of ARA was more common on right side. A study conducted in India reported incidence of ARA 12 % present on right side and 7.3 % on the left side.[15] In Greece overall incidence of ARA was 11.2 % (23/206), on the right side 52 % (12/23) and on the left side 47.08% (11/23).[27] In China the incidence was reported to be 14.5%.[28]

In present study on comparing frequency of ARA between genders, frequency was found to be more in males as compared to females but difference was statistically insignificant (p=0.577). This is in accordance to a study conducted in Malaysia, in which reported incidence was 28% in males and 5.1% in females.[29] Literature review showed that variation in the incidence of presence of ARA in different studies was probably due to a complex embryogenesis of kidneys and renal vasculature.[12,30]

In our study among different types of accessory renal arteries we found most frequent superior polar artery 14.9% (n=37), then hilar artery was 10.2% (n=26) and lowest frequency of inferior polar artery 1.3% (n= 3). A study conducted in India reported highest incidence of hilar accessory artery 22.6 %, than superior polar artery was 13.1 % and lowest incidence of inferior polar artery 7.1%.[31] Another study conducted in Poland reported superior polar artery 4.7%, hilar 7% and inferior polar artery 8.7%. (30) A study conducted in Caribbean population reported upper polar artery present in 10.2 %, hilar 19.2% and lower polar artery present in 17.5 % individuals.[17]

A complete description of renal arteries and its variation should be reported for preoperative assessment and kept in mind during radiological intervention, endovascular and urological surgical procedures. To the best of our knowledge this was the first study which provides incidence of accessory renal artery in adults in our set of population by using one of the most accurate modality MDCT scan recommended to assess renal vasculature.

CONCLUSION

Frequency of ARA in our studied population was found to be 26.4%. It is comparable to Asian population. Frequency of ARA is more in males as compared to females.

However, a large multicentre nationwide study should be done in future to further support our result.

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3	Iffat Raza	Clinical support & statistical analysis.	
4	Mahrukh Kamran	Reviewing article & final drafting.	
5	Hemant Kumar	Compiling results & guidance.	
6	Sahar Mubeen	Clinical support & literature search.	