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Frequency of branching pattern variation of the renal artery in a subset of Karachi population: A Study on Multi-Detector Computed Tomography

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Abstract

Objective: This study was conducted to determine the frequency of early branching patterns of renal arteries in a subset of Karachi.

Method: This was a cross-sectional study, conducted in Ziauddin University Hospital, Clifton campus, Karachi. This was a prospective study conducted from June 2017 to July 2018. The sample size was calculated by using a 95 % confidence interval and study participants were included through consecutive sampling. A total of 250 participants (500 kidneys) aged 21 to 60 years and serum creatinine of ≤ 1.3 mg /dl were included in the study. All CT examinations were performed on an MDCT scanner (Alexion 16 slicer, Japan) in the arterial phase.

Result: In this study, among a total of 250 study participants, 52 % (129 out of 250) were males and 48 % (121 out of 250) were females. Out of a total of 250 study participants, renal artery variation of pre-hilar early branching was found to be 9.2% (23) in individuals. On the right side early was found to be 4% and 5.2%. The length of the main renal artery in early branching measured was 11.0 ± 2.05 mm.

Conclusion: This study concluded that the frequency of early branching of renal arteries was 9.2% in a subset of the Karachi population.

Keywords: renal artery, kidney, computed tomography.

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1. Introduction

Morphological changes in kidney size are manifested by many renal pathologies and are of great significance in the clinical evaluation and management of patients with kidney diseases.[1] In the circulatory system renal arteries play an important part, as they carry about 20%of total cardiac output to the kidneys. Renal arteries have a diameter of average around 5mm and a length of about 40 to 60 mm. The incidence of renal transplantation and endovascular interventions is increasing. With the emergence of the latest radiological techniques in the current age, information regarding variations of renal arteries in diameter, range of length, pattern of division and occurrence of accessory renal arteries is significant for surgeons.[2] According to Breno Jose et al, no anastomosis between renal arteries, thus they are considered to be end arteries.[3] However, in laparoscopic renal surgeries, donor nephrectomies and interventions like open aneurysm repair, and graft deployment during endovascular aneurysmal repair, surgeons need to recognize the variations in the renal vasculature, otherwise renal surgeries may be endangered.[4-7]

Kidneys are supplied by paired renal arteries. Usually, arteries arise laterally from the aorta just beneath the origin of the superior mesenteric artery, the intervertebral disc between the L1 and L2 vertebrae.[8] Typically renal arteries enter the renal hilum and divide into two main divisions, anterior and posterior. Each main branch further divides and gives rise to five segmental branches, supplying vascular segments in the kidney.[9] The posterior division gives rise to the posterior segmental artery which supplies the posterior segment of the kidney, while the anterior division gives rise to the apical segmental artery which supplies the apical segment, the anterior superior segmental artery supplies the anterior superior segment, anterior inferior segmental artery supplying anterior inferior segment and inferior segmental artery supplying inferior segment.[8]

Variations of renal arteries are classified as early division and extrarenal arteries.[4] The renal artery divides into segmental branches that occur proximally (any branch less than 1.5 cm) to the renal hilum level, it is called early division (Figure 11b).[4,10] It is imperative for surgeons and interventional radiologists, to identify early division of renal arteries

as a 2cm length of main renal artery is required for adequate control of bleeding and anastomosis during laparoscopic renal surgeries. [5,11]

Variations in renal artery measurements have been reported to vary in studies conducted on different populations. Literature review showed previous studies conducted in Turkey and Brazil reported variation in measurements of the renal artery with side, gender and age.[3,10,12] Therefore, this study was conducted to determine the percentage of early branching of renal arteries in our population.

Literature review revealed that very few studies have been conducted on renal arteries and their variations in our part of the world. Therefore, the objective of our study was to determine of incidence of one of the variations of renal artery which is early branching in our population of Karachi.

2. Materials & Methods

This was a cross-sectional study conducted at Ziauddin University Hospital, Clifton campus, Karachi. The study was conducted from June 2017 to July 2018, taking approval from the ethical review board. The sample size was calculated at a 95 % confidence interval and study participants were included through consecutive sampling. Analysis of data was done on SPSS version 21. For qualitative variables (gender and early division) frequencies and percentages were calculated. Quantitative variables were reported as mean and standard deviation was calculated. A total of 250 participants (500 kidneys) 21 to 60 years of age and serum creatinine ≤ 1.3 mg /dl were included in the study. However, exclusion criteria were a history of renal transplant, renal surgery, and history of contrast hypersensitivity, Hypertension, Diabetes Mellitus, congenital renal anomaly and pregnancy.

With the introduction of new technology, Multi-slice Computed tomography (CT) scans with three-dimensional reconstructions can be used to measure and study renal vascularization.[13] It has different phases, its arterial phase is the most sensitive phase, as it correctly defines renal arterial anatomy in 97.6% of patients and sensitivity is 100% in the visualization of accessory renal arteries.[14] MDCT scan is an advanced technology that allows the simultaneous acquisition of multiple images during a single rotation of an X-ray tube.[15] In this study, Multi-planar reformation (MPR) and MIP images were used to study renal arteries and their variations.[16] The MIP (maximum intensity projection) images consist of projecting the image with the highest attenuation value on every view. Precise renal artery measurements are required for pre-surgical renal artery embolization in renal cell carcinoma. In robotic surgery, accurate information about renal artery dimensions and its variations is necessary because surgeons working in robotic consoles have difficulty in the identification of arteries.[17]

In this study, Multi-slice three-dimensional computed angiography was performed at Ziauddin University Hospital. MDCT angiography scan is an advanced technology that allows the simultaneous acquisition of multiple images during a single 360-degree rotation of X-rays. All CT examinations were performed on a MDCT scanner (Toshiba 16 slicer Alexion, Japan) in the arterial phase. All measurements were taken under guidance of radiologist and CT- technician. Multi-planar reformation (MPR) is performed, using volumetric data of CT images to create three-dimensional images. MIP (maximum intensity projection) images consists of projecting the image with the highest attenuation and were used for accurate visualization of the renal artery along its route. (Figure:1).

Early branching renal arteries (which is any branch within 1.5 cm of origin of renal artery from the aorta, [18] was reported (Figure 2).

Figure 1: MDCT scan Maximum Intensity Projection (MIP) axial image with curved planar reconstruction showing bilateral renal arteries and kidneys during the study.

Figure 2: MDCT-scan Multi-planar projection reconstruction (MPR) coronal image showing the early division of the right main renal artery during the study.

3. Results

In this study 250 participants were included and 500 renal arteries were studied. Study participants mean age was 43.9 ± 11.8 years, ranging from a minimum of 21 years to a maximum of 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 of males and females was 43.5 ± 11.0 years and 44.3 ± 12.6 years respectively. Mean renal artery measurements are shown in Table 1.

Table 1: Renal artery measurements of study participants (n=250)

Parameters	Right renal artery Mean ± standard deviation (mm)	Left renal artery Mean ± standard deviation (mm)
Renal artery diameter	6.66 ± 0.39	6.79 ± 0.36
Renal artery length	44.69 ± 2.48	35.10 ± 2.86

However, out of a total of 250 study participants early branching of the main renal artery was observed in 9.2% (23) individuals (Figure 3). On the right side early was found to be 4% and 5.2% (Figure 4). On measuring length of main renal artery in early branching, was to be 11.0 ± 2.05 mm.

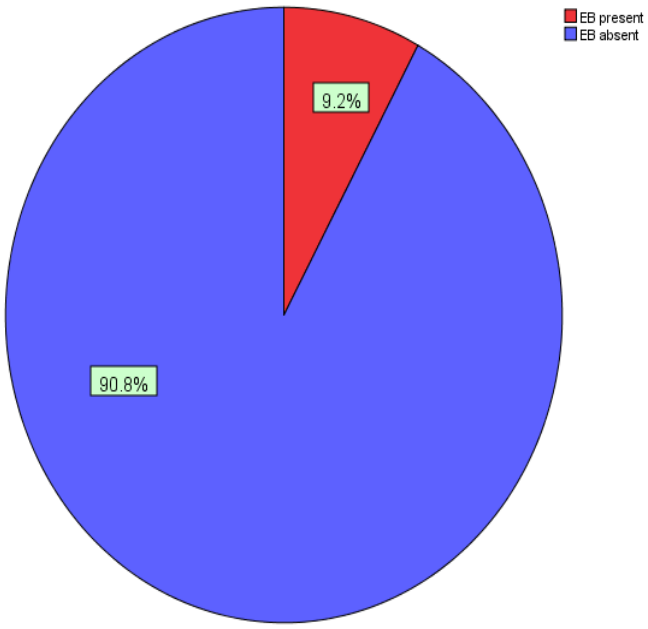

Figure 3: The Pie chart showing the frequency of early branching (EB) of main renal artery.

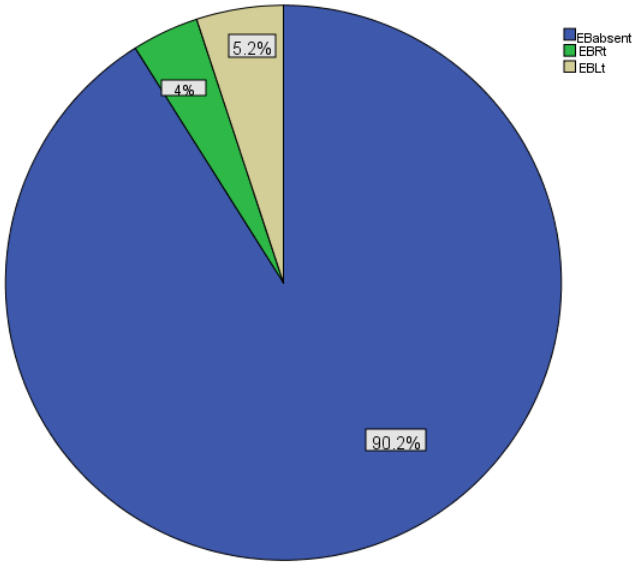

Figure 4: The Pie chart showing the frequency of early branching (EB) of main renal artery on right and left side.

4. Discussion

Kidneys are paired with highly vascularized organs where precise regulation of blood flow is critical for performing numerous homeostatic functions, regulation of body fluids / electrolytes, blood pressure, and blood pH.[19] In diseased states (for instance, kidney disease, renal transplantation, surgery, hypertension) quantification of renal hemodynamics is of great interest.[20]

For selection of kidney donors, detailed anatomy and dimensions of renal arteries are important since its impact on renal surgeries, urology, renal angiography and renal artery stenting. Moreover, the literature review revealed that many studies had been conducted on renal arteries in different parts of the world using angiography. However, limited data available regarding renal artery variations conducted in our country.

In this study, the frequency of early branching was found to be in 9.2% (n = 23) out of 250 study participants. Our results are from a study conducted in Chennai, which reported a 13% frequency of early branching of the renal artery.[21] Another study conducted in India in which the frequency of early division of the main renal artery was reported to be 11.67%.[22] A study conducted in Ethiopia reported a frequency of 10.8% in kidney donors.[23] Another study conducted on living renal donors in Germany reported early branching in 3% of individuals

out of 140 individuals. The low frequency is probably due to the use of only one phase of CT angiography.

In the present study, variation in early branching was also found different on the right and left sides. On the right side, early division was found in 4.0% (n = 10) and 5.2% (n = 13). The prevalence of variation varies with different populations. A study conducted by M Kumaresan et al reported 8% and 12%, respectively on the right and left side.[24] In the Turkish population frequency was 9%, on the right side 6% on the right side and 3% on the left side. [25] A study from Egypt reported 7% on the left side and 5% on the right side. Another study by Won Hoon et al reported the frequency of early branching at 13% on the right side and 10 % on the left side.[26]

To evaluate the normal anatomy of renal vascular structures as well as its variations computed tomography is reported by different studies to be an excellent method of imaging.[7,27] The occurrence of accessory renal arteries is one of the most common renal vasculature variations.[28] The presence of early branching of the renal artery is another common variant evaluated in the present study. On comparing our study with the study conducted to evaluate the variation of the renal vasculature, results are varied as early or pre-hilar branching was found to be 7.1%, on the right side 4.2% and on the left side 2.2%.[29]

5. Conclusion

This study concluded that the frequency of early branching of renal arteries was found to be 9.2% with a variation on the right and left side in our population. This is comparable with other Asian populations. To the best of our knowledge, very few studies were conducted in our part of the world. This knowledge will be useful to nephrologists, urological surgeons and many endovascular surgeries involving renal arteries. However, studies on a large scale will be needed to support the data.

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