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Anatomical Variations of Renal Artery Studied by Computed Tomography in a Tertiary Care Center in Nepal

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ABSTRACT

Background: Each kidney is normally supplied by a single renal artery originating from the abdominal aorta. A lot of renal surgeries are routinely done nowadays, so it has become increasingly necessary for surgeons to understand the abnormalities and variations in the renal vasculature. The aim of this study was to determine anatomical variations of renal arteries in the Nepalese population.
Materials and methods: This cross-sectional study was performed in the Department of Radiology and Imaging on a total of 125 patients (57 male and 68 female) of age range 18-65 years who underwent Contrast Enhanced Computed Tomography (CECT) of the abdomen from November 2020 to April 2021.
Results: Renal artery variations were found in 49.6% of the patients. Among them, 24% individuals had early hilar division of renal artery, 8.8% individuals had aberrant renal artery and 21.6% individuals had accessory renal artery. In early hilar division of renal artery, 13.6% individuals had right sided early hilar division, 7.2% individuals had left sided early hilar division and 3.2% individuals had bilateral early hilar division. In aberrant renal artery, 6.4% individuals had aberrant renal artery on right side and 2.4% individuals had aberrant renal artery on left side. In accessory renal artery, 8% individuals had accessory renal artery on right side, 11.2% individuals had accessory renal artery on left side and 2.4% individuals had bilateral accessory renal artery. The difference in prevalence of aberrant renal artery in males and females was statistically significant (p=0.05).
Conclusion: Renal artery variations are very common. Most common variations found in this study included early hilar division of renal artery, aberrant and accessory renal artery. The incidence of early hilar division of renal artery was more common than aberrant and accessory renal artery in our study population.

Keywords: Anatomical variations, Computed tomography, CECT, Renal Arteries.

INTRODUCTION

Renal artery variations are divided into 2 groups: early division and extra renal arteries. Branching of the main renal arteries into segmental branches more proximally than the renal hilus level is called early division. Extra renal arteries are divided into 2 groups: hilar (accessory) and polar (aberrant) arteries. Hilar arteries enter kidneys from the hilus with the main renal artery, whereas polar arteries enter kidneys directly from the capsule outside the hilus. [1,2,3,4] Superior polar artery is the branch of aorta that enters the kidney at the upper pole CT is an excellent imaging technique for the assessment of renal vasculature. The origin,

number, size, and course of renal arteries are easily identified by CT abdomen. Sensitivity of CT is best in demonstrating the course of main renal arteries. Three-dimensional volume rendered computed tomographic provides a fast, noninvasive modality for the evaluation of the renal vascular pedicle. [5,6,7]
Before the advent of MDCT, renal donors underwent radiographic evaluation with intravenous radiography (IVU) and renal and aortic angiography. These techniques depicted renal size, calculi, calcification and anatomy of the collecting system but venous anomalies were not properly assessed. For this reason, the procedures have been replaced with MDCT since it offers unquestionable advantages.[8] CT is less invasive, better tolerated by donors and provides significantly more information than intravenous urography and angiography together, especially regarding abdominal anatomy and vascular pathway.[9,10,11]
Some of the clinical implications of variants of renal arteries are:
Upper polar artery is frequently located high up in the kidney. Many surgeons may mistake it for surrounding connective tissue and cut through it causing massive bleeding. An accessory renal artery going to the lower pole of the kidney in front of the ureter may compress the ureter and cause hydronephrosis. Accessory renal arteries act as a feeding artery for the renal cell carcinoma.
Clinically, the identification of renal vascular variants is important especially for transplantation surgeons, urologists during urological procedures, vascular surgeons during repair of abdominal aortic aneurysm and for radiologists during angiographic interventions. CECT is an excellent imaging technique for the assessment of renal vasculature. The origin, number, size and course of renal arteries are easily identified in arterial phase scan during triple phase contrast enhanced CT of abdomen.
The main objective of this study was to determine anatomical variations of renal arteries in patients undergoing CECT scans of the abdomen in the Department of Radio-diagnosis at Chitwan Medical College. This study was also done to determine the frequency of anatomical variation of renal arteries (aberrant, accessory, early hilar division) and to determine the relationship of anatomical variation of renal arteries with age group and gender.

METHODOLOGY

This study was performed in the Department of Radiology, Chitwan medical college teaching hospital. All adult patients referred for CECT abdomen for various clinical indications who consented to the study and did not have any history of renal trauma or renal surgery were included in the study. The study was conducted from 16 November, 2020 to 25 April, 2021. Purposive sampling method was used for data collection. CT Imaging was performed on Siemens Somatom Definition AS+128 Slice (Siemens Healthineers, Germany). The examinations were performed as per the protocol of the department as follows:

- 600 ml plain water 30 minute before and then 400 ml just before examination.
- Scanning area coverage: Dome of diaphragm to iliac crest.
- Detector collimation: 0.6x128
- Pitch: 1
- Kv: 120
- mAs: 200 (AEC)
- Contrast: Intravenous. Low Osmolar Contrast Media
- Volume: 80-100ml at rate of 3.5-4 ml/s
- Recon slice and interval: 1.25x1.25mm

Phased scanning of the abdomen was done. Arterial Phase was performed18-20 seconds after bolus tracking, portal phase was done 45-55 seconds and venous phase was performed 65-70 seconds after bolus tracking. Arterial phase images were used for image interpretation. Afterward, axial and coronal maximum intensity projection (MIP) and volume rendering technique (VRT) image were used for image evaluation. The obtained data were analyzed using statistical software (SPSS version-20) after reviewing of accuracy and completeness in terms of descriptive statistics and P- value inferential

statistics. Ethical approval was taken from the Institutional Review Committee of Chitwan Medical College.

RESULTS

Out of total 125 patients included in our study, 57(46%) were male and 68(54%) were female. The age of patients ranged from 19 to 65 years with the mean age of 45.

The results can be categorized and presented under the following headings:

a. Anatomical variation among total population: The most common anatomical variation of renal artery was early division of the renal artery on the right side 17(13.6%)) followed by accessory artery on left side 14 (11.2%),accessory artery on left side 10(8%),early hilar division on left side 9(7.2%), inferior polar artery on right side 6(4.8%),bilateral early hilar division 4(3.2%),bilateral accessory artery 3(2.4%), superior polar artery on right side 2(1.6%), superior polar artery on left side 2(1.6%)and inferior polar artery on left side1(0.8%).

b. Anatomical variation among gender: Early division of renal artery was seen in 14 males and 16 females. Out of 14 males,10 (71.4%) males had right sided early hilar division of renal artery ,2(14.3%) males had left sided early hilar division of renal artery and 2(14.3) males had early hilar division of renal artery in bilateral kidneys. Similarly, out of 16 females,7(43.8%) females had right sided early division of renal artery as well as left sided early division of renal artery and 2 females had early division of renal artery in bilateral kidneys. Among aberrant renal artery type, superior polar artery was seen in 1 male and 3 femlaes.1 (100%) male had right sided superior polar artery. Out of 3 females, 1(33.3%) female had right sided superior polar artery and 2(66.67%) females had left sided superior polar artery. Moreover in another aberrant renal artery type, inferior polar artery was seen in 1 male and 6 females.1 (100%) male had right inferior polar artery. Out of 6 females,5(83.33%) females had right sided inferior polar artery and 1(16.67%) female had left sided inferior polar artery. Accessory renal artery was seen in 12 males and 15 females. Out of 12 males, 5(41.7%) males had right sided accessory renal artery, 6(50%) males had left sided accessory renal artery and 1(8.3%) male had accessory renal artery in bilateral kidneys. Similarly, out of 15 females, 5(33.3%) females had right sided accessory renal artery, 8 (53.3%) females had left sided accessory renal artery and 2 (13.3%) females had accessory renal artery in bilateral kidneys.

c. Association between normal and anatomical variation with gender: Out of 57 males, 30(52.6%) males had normal and 27(47.4%) males had anatomical variation of renal artery. Out of 68 females, 33(48.5%) had normal and 35(51.5%) had anatomical variation of renal artery. There was statically insignificant association between normal and anatomical variation of renal artery with gender (P=0.648).

d. Association of anatomical variation with gender: Early hilar division in males were 14(46.1%) and females were 16(53.3%) with p value of 0.893 which was statistically insignificant. Aberrant renal artery in males were 2(18.2%) and females were 9(81.9%) with p value of 0.05 which was statistically significant. Accessory renal artery in males were 12(44.4%) and females were 15(55.6%) with p value of 0.892.

Table 1: Association between Normal and Anatomical Variation of Renal Artery with Gender of Patients n=125

Gender	Normal	Anatomical variation of renal artery	P -value
Male	30(52.6%)	27(47.4%)	0.648
Female	33(48.5%)	35(51.5%)	
Total	**63**	**62**	

Table 2: Association of Anatomical Variation of Renal Artery with Gender of Patients n=68

Variable	Male	Female	P- value
Early hilar division	14(46.1%)	16(53.3%)	0.893
Aberrant renal artery	2(18.2%)	9(81.9%)	0.05
Accessory renal artery	12(44.4%)	15(55.6%)	0.892

DISCUSSION

We aimed to observe the anatomic variations in renal artery in the two genders and find out the association of these two variables. The study on anatomical variations in vascularization of kidney is very important for transplant surgeons involving in donor nephrectomies. With this knowledge, the radiologist can enlighten the surgeon which helps to explore and treat renal trauma, renal transplantation, renal vascular embolization, angioplasty and radical renal surgeries.

Regarding normal renal arteries, the study found that most of the individuals had normal renal artery which was 50.4% of total population. The study conducted by Munnusammy et al.[12]also found the similar result to our study that was 49% of total population had normal renal artery. Likewise, the study conducted by Gumus et al.[13] and OC Famurewa et al.[14] also found similar result to our study that was 46.07% and 50% respectively.

The early hilar division of renal artery was observed in 30(24%) of individual. Right side early hilar division was found in 17(13.6%) individuals, left side early hilar division was found in 9(7.2%) individuals and bilaterally early hilar division was found in 4(3.2%) individuals. The study done by Gumus et al.[18] found 219(26.70%) prevalence of early hilar division of renal artery where right side early hilar division was found in 134(16.3%) individuals, left side early hilar division was found in 136(16.6%) individuals and bilaterally early hilar division was found in 49(6%) individuals. Munnusammy et al.[12] found that prevalence of early hilar division of renal artery was 13 (13%) where right side early hilar division was found in 5(5%) individuals, left side early hilar division was found in 7(7%) individuals and bilaterally early hilar division was found in 1(1%) individual. The reason behind difference in result between study by Munnusammy.[12] and our study may be related with ethnicity.

In this study, the aberrant renal artery was observed in 11(8.8%) of individual. The superior polar renal artery was found in 4(3.2%) individual where the right side superior artery was found to be 2(1.6%) and left side superior polar artery was 2 (1.6%). The inferior polar was found in 7 (5.6%) individuals out of which 6(4.8%) was right sided inferior polar renal artery and 1(0.8%) was left sided inferior polar renal artery. Study by Kornfel et al.[15] found that prevalence of aberrant renal artery in 54(13.43%) individuals. The superior polar renal artery was found in 19(4.7%) individuals out of which the right side superior artery was found to be 6(1.4%) and left side was 13(3.2%). The inferior polar was found in 35(8.7%) individuals out of which 13(3.23%) was right sided inferior polar artery and left sided inferior polar artery was 12 (5.4%). This result was similar to our study. Whereas study by OC Famurewa et al.[14] found aberrant renal artery in 46(23%) individuals. The superior polar renal artery was found in 15(7.5%) individuals out of which the right side superior artery was found to be 11(5.5%) and left side was 4(2.1%). The inferior polar renal artery was found in 31(15.5%) individuals out of which 11(5.5%) was right sided inferior polar renal artery and 20(10%) was left sided inferior polar renal artery. The difference between other studies and our study can be explained by the reasons related to the study population.

In relation to accessory renal artery, in the study done by OC Famurewa et al.[14] there was prevalence of accessory renal artery of 23%. Another study done by Gumus et al.[13] found 27% prevalence of accessory renal artery. Munnusammy et al.[12] found that prevalence of accessory renal artery 38%. In our study, there was a 21.6% individual with accessory renal artery which is comparable to other studies.

In our study we found left accessory renal artery in 11.2%, right accessory renal artery in 8% and bilateral accessory renal artery in 2.4% population. Similar result was found in the study done by Satypal et al.[2] where left accessory renal artery 32%, right accessory renal artery 23.3% and bilateral accessory renal artery 10.2%. Another study by

Munnusammy et al.[12] found that the left accessory renal artery 13%, right accessory renal artery 13% and bilateral accessory renal artery 12%.

The prevalence of early hilar division in male and female was found statistically insignificant with p value of 0.893(df =1). In contradictory to our study, Gumus et al.[13] found that the prevalence of early hilar division was statistically higher in male than female. In our study, the difference in prevalence of aberrant renal artery in male and female was significant with p value of 0.05 (df =1), with the aberrant renal arteries being more common in females than males. In contrast, the study performed by Zainel et al.[16] showed the prevalence to be statistically insignificant over gender. Our study showed that prevalence of accessory renal artery had no statistical significance over gender (p value =0.892). Similarly, the study done by Maleki et al.[17] also showed similar statistical insignificance over gender.

CONCLUSION

Anatomical variations of the renal artery are fairly common. We found renal artery variations in 49.6% of the study population. The incidence of early hilar division of renal artery was found to be more common than other variations of renal artery such as aberrant renal artery and accessory renal artery. Prevalence of aberrant renal artery was more common in females than males (p=0.05) whereas prevalence of early hilar renal artery and accessory artery were found to be statistically insignificant over gender.

Declaration by Authors

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