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Renal Artery Caliber In Abdominal CT Scan With IV Contrast Based on Age and Gender

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ABSTRACT

Introduction: CT scan provides several three-dimensional images when reconstructed, high speed, accurate, less invasive, and relatively low cost. The size of renal arteries varies based on influencing factors such as age, gender, and location. Several studies reported variations in the dimensions of the renal arteries based on sex, age, and variations of the arteries. The purpose of research objectives is to analyze factors affecting the caliber of the renal artery in patients with abdominal CT Scan with intravenous contrast procedure.

Method: A case-control study in patients with abdominal CT Scan with intravenous contrast procedure. Data was secondary data obtained by medical records of patients who have undergone a CT scan of the Abdomen with intravenous contrast.

Results: The caliber of the right renal artery in subjects ≤40 years (5.19±0.53 mm) was greater than those> 40 years (4.58±0.66 mm). Statistically, based on the Independent T-test, found that there was a significant difference in the mean caliber of the right renal artery ($p < 0.01$) and the left renal artery ($p=0.01$). The mean of the caliber of the right and left renal arteries in male subjects (5.05±0.69 mm) was greater than women (4.7±0.60 mm). The results of the Independent T-test showed that there was a difference in male subjects than women with a p-value of the right renal artery caliber ($p=0.04$) and left ($p=0.02$).

Conclusion: There was a difference in the mean caliber of the renal arteries by the CT scan of the abdomen with intravenous contrast based on age and gender.

Keywords

Age, Gender, Renal Artery

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INTRODUCTION

Renal Artery Disease (RAD) is considered the most common cause of secondary hypertension which is potentially curable and if left untreated will lead to end-stage renal disease which is found in up to 5% of patients with hypertension and patients with symptoms suggestive of renovascular hypertension can lead to the prevalence of renal artery disease. increased to 20-40%.[1] The prevalence of End Stade Renal Disease (ESRD) in Indonesia has continued to increase over the past decade. The most common risk factors are diabetes mellitus (DM) and hypertension.[2] Abnormalities associated with the renal arteries include renal artery stenosis (RAS), renal artery aneurysm, renal artery dissection, fibromuscular dysplasia and renal transplant.[3,4]

Therefore, it is very important to know the exact caliber range, length and exact location of origin of the renal arteries for an accurate assessment of the kidneys in planning for kidney transplantation. Measurement of renal artery caliber is very important for radiologists in determining the diagnosis and prognosis of a disease,

and plays a role in determining medical treatment.[3] Various studies have been performed in various parts of the world to establish the normal reference range for renal artery size.[5]

Measurement of the renal arteries with the use of Computed Tomography (CT) Scan modalities has many advantages, including high speed, acquisition, accuracy, less invasiveness, and relatively low cost compared to magnetic resonance angiography (MRA). In addition, a CT scan provides several three-dimensional images when reconstructed.[6] Sectional imaging computed tomography has helped in clarifying and showing a better picture of the anatomical structure. This allows the study of organ size and dimensions as well as morphology to help make clinical decisions. Furthermore, examination of renal artery caliber through abdominal CT Scan with intravenous contrast can be used to determine pathological abnormalities of Renal Artery Disease (RAD) such as renal artery stenosis and renovascular hypertension. Anatomical features of the renal arteries are very important to understand the process of renal perfusion. It is not only the number of renal arteries that affects the level of renal blood supply, but also their caliber.[2]

The size of the renal arteries varies based on influencing factors such as age, gender. In a study in Pakistan it was stated that a significant difference ($p = 0.001$) of the mean caliber of the right and left renal arteries was observed between men and women. In other study, [7] women were found to have significantly ($p = 0.001$) mean renal artery caliber and smaller right and left renal artery lengths compared to men. A recent study conducted at the University of Virginia reported that the length and caliber of the bilateral renal arteries were greater in men than in women ($p < 0.001$) and concluded that this variation in measurements was due to the relatively large body size of men compared to women.[2,6] In the study in Pakistan, subjects were grouped into four age groups namely group-1 (21 to 30 years), group-2 (31 to 40 years), group-3 (41 to 50 years) and group-4 (51 to 60 years). Based on age, it was stated that there was a significant difference in the size of the renal artery caliber in each age group for the right and left renal artery caliber ($p < 0.001$).[7,8]

Management decisions are often based on comparison of observed renal artery caliber with normal variation. Therefore, for the definition and classification of structural abnormalities, such as aneurysms, stenosis, etc., knowledge of normal renal artery caliber is important. Currently there is no data on the relationship between renal artery caliber with age and sex in Indonesia, especially North Sumatra. Therefore, it is important to conduct this study to analyze the factors that affect renal artery caliber in patients undergoing abdominal CT Scan with intravenous contrast at Haji Adam Malik (HAM) Hospital Medan.

METHOD

This study was a case control study in patients who underwent abdominal CT Scan with intravenous contrast at HAM Hospital Medan. Data collection has obtained permission from the Ethics Committee for the Implementation of Health Research, Faculty of Medicine, University of North Sumatra with Number of Letter was135/KOMET/FKUSU/2020. The population of this study were all patients who underwent CT Scan of the abdomen with intravenous contrast with a minimum sample size of 11 people. To facilitate statistical tests, 30 people were assigned to each group. So the total research subjects were 60 people.

Inclusion criteria included the age of the research subjects between 18 - 70 years. Data has the results of an abdominal CT scan with intravenous contrast of patients at HAM Hospital Medan in 2019-2020. Serum creatinine level < 1.3 mg/dL. While the exclusion criteria were patients with systemic disease (hypertension, Diabetes Mellitus) affecting the renal arteries, patients with a history of kidney transplantation, patients with a history of kidney surgery, patients with a history of vascular anomalies in the kidneys and patients with anatomical abnormalities of the kidney.

The data is secondary data from 2019-2020. The data consisted of dependent variable data (renal artery caliber) and independent variables (age, gender). The process of scanning with intravenous contrast, namely a CT scan, was performed using a standard protocol 16-slice MDCT scanner (GE Bright Speed 16). Before scanning, empty the stomach and intestines. Contrast material ultravist was administered intravenously through the ante cubital fossa at a rate of 4 ml/sec and injected contrast of 2 ml/kgBW. The patient was instructed to hold his breath for 10s and the scan was started. The scanned area was extended from the

diaphragm to the iliac crest. Image data acquisition was initiated after a 10 to 15 second delay after the start of contrast agent injection. The image data is transferred to an imaging workstation (Medical System CT-scan Bright Speed 16), which is used to transmit volumetric MDCT data. The caliber and length of the renal arteries were measured. Caliber was measured in the proximal, medial and distal segments of the renal artery, then divided by three to obtain the mean renal artery diameter. Renal artery caliber was measured by the researcher and one radiologist at HAM Hospital, Medan.

Data from the collection of samples were verified manually (data editing was performed). Editing was performed to check the completeness of the medical record data by assessing the caliber of the left and right renal arteries, the patient's age (in units of years then categorized) and the gender of the subject. If there is incomplete data, it is excluded from the analysis. All data analyzed using SPSS version 22.0. Bivariate analysis was analyzed using the appropriate test to examine differences in renal artery caliber by age and sex. The data was normally distributed, then statistical analysis used independent t-test. Data reported as total number of each group (n) with statistical significance set a priori at $p<0.05$.

RESULTS

Data collection was performed for 3 months from February to April 2021. Data was obtained by collecting medical record data from patients who had an abdominal CT Scan with intravenous contrast examination at HAM Hospital Medan in 2019-2020. Overall the number of patients who underwent CT-Scan Abdomen with intravenous contrast was 1789 people. Of these, 968 patients were women (54.1%) and the most age was > 40 years, namely 1239 people (69.3%), as presented in table 1 below. Then data were taken as many as 60 patients who met the inclusion and exclusion criteria. Data retrieval using consecutive selection. Then the renal artery measurements were made based on the characteristics of the research subjects. Calculation of the size of the renal arteries was done directly by researchers under the supervision of a Radiology Specialist. The research subjects were 60 people. The characteristics of the research subjects are presented in the table below.

Table 1. Characteristics of Subjects

Characteristics	N	%
Age		
≤ 40 y.o	30	50
> 40 y.o	30	50
Gender		
Man	30	50
Woman	30	50

The distribution of respondents according to individual characteristics shown in table 1 above shows that from the data obtained the proportion based on age ≤ 40 and > 40 years is 50% respectively. Based on gender, the number of male and female samples was 30 samples (50%).

Tabel 2. Characteristics Renal Artery Caliber

Characteristics	Mean + SD
Right Renal Artery Caliber (mm)	4,87 ± 0,67
Left Renal Artery Caliber (mm)	5,25 ± 0,67

Based on the results of the study, there were also 8 research subjects who had accessory arteries in the renal arteries. The figure below shows several types of accessory arteries found in this study.

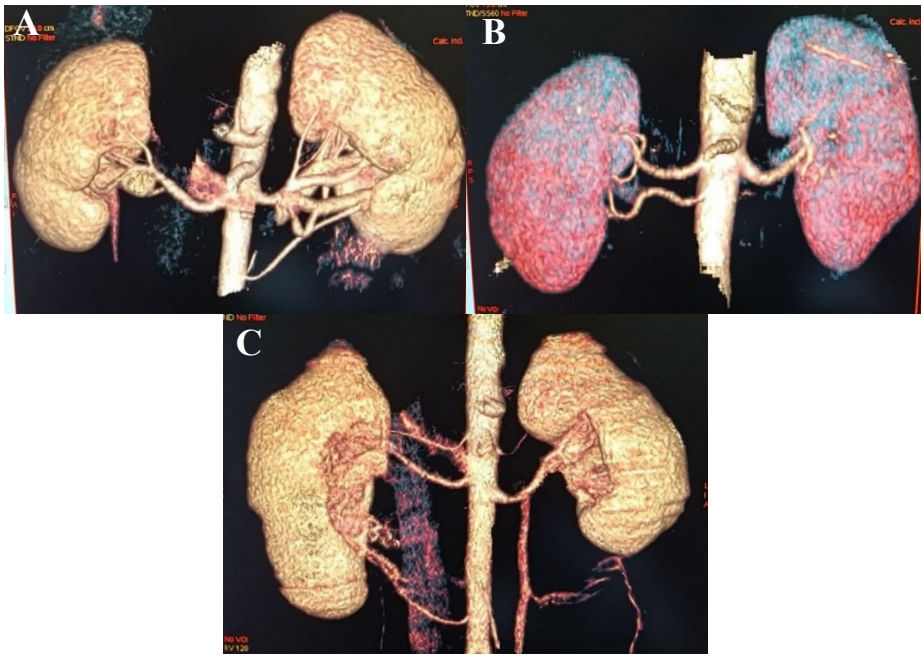

Figure 1. Coronal Volume Rendering image (a) showing the accessory artery at the lower pole of the left kidney and (b) the lower pole of the right kidney originating from the branch of the abdominal aorta. (c) shows the accessory arteries in the upper and lower poles of the right kidney and the upper pole of the left kidney originating from the branch of the abdominal aorta.

Tabel 3. Relationship between renal artery caliber with age and gender

Characteristics	Right Renal Artery Caliber (mm)		Left Renal Artery Caliber (mm)	
	Mean + SD	p	Mean + SD	p
< 40 y.o	5.19 + 0,53	<0.01*	5.49 + 0,59	0.01 *
> 40 y.o	4.58 + 0,66		4.93 + 0,63	
Man	5.05 + 0,69	0.04*	5.41 + 0,65	0.02 *
Woman	4.7 + 0,60		5.08 + 0,63	

* Independen T-Test

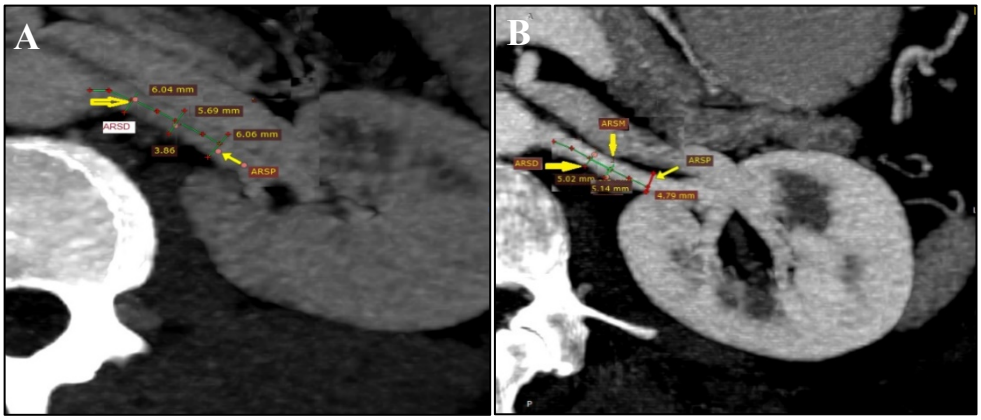

Figure 2 Axial maximum intensity projection (a) male patient with mean left renal artery caliber = 5.93 mm and (b) female patient with mean left renal artery caliber = 4.98 mm

Table 3 shows that the caliber of the right renal artery in subjects $\leq$ 40 years old (5.19 $\pm$0.53 mm) was greater than in subjects > 40 years (4.58 $\pm$ 0.66 mm). The same is true for the left renal artery. In a bivariate test using an independent t test, it was found that there was a significant difference in the mean caliber of the right renal

artery ($p < 0.01$) and left renal artery ($p = 0.01$) in the study subjects $\leq$ 40 compared to age > 40 years. The results of the analysis of the caliber of the right renal artery in male subjects (5.05 $\pm$ 0.69 mm) were greater than women (4.7 $\pm$0.60 mm) with $p = 0.04$ ($p<0.05$). Likewise, the left renal artery was found in males (5.41 + 0.65 mm) and females (5.08 $\pm$ 0.63 mm) with $p = 0.02$ ($p<0.05$).

DISCUSSION

The distribution of respondents according to individual characteristics shown in table 1 above shows that from the data obtained the proportion based on age $\leq$ 40 and > 40 years is 50% respectively. Based on gender, the number of male and female samples was 30 samples (50%). In this study, the renal artery caliber was 4-6 mm. this is in accordance with Hazirolan T's study which stated that the average renal artery has a length of 4-6 cm and a diameter of 5-6 mm.[8] On average, the caliber of the left renal artery is wider than that of the right renal artery. Based on the study of Schoner E, it was stated that based on the location of the artery, it was stated that the left renal artery was wider than the right renal artery.[5] In comparison with this, the study of Mohiudin M, et al in Pakistan stated that the size of the left renal artery was 6.79 ± 0.36 mm and right renal artery 6.66 ± 0.39 mm.[9,10] The results reported in a study conducted in Columbia showed that the diameter of the right renal artery was significantly smaller than that of the left renal artery.[10]

Based on the results of this study, there were also 8 study subjects who had accessory arteries in the renal arteries. In the study of Perez et al., it was stated that about 30% of individuals had more than one artery present.[10] Variations in the renal arteries can be classified based on the number of arteries and the origin of the arteries. The normal or accessory variations of the renal artery may arise from the upper part of the main branch of the abdominal aorta or lower (inferiorly) from the internal iliac artery. Several variations of origin such as iliac arteries, superior and inferior mesenteric arteries, celiac arteries, middle colic arteries, lumbar arteries, middle sacral arteries and contralateral renal arteries have been reported.[11] The prehilar (initial) branches of the renal artery are the normal variant in which each branch diverges within 1.5-2 cm of the lateral wall of the aorta in the left kidney or in the retrocaval segment of the right kidney. This variant is very important in transplantation, as the surgeon requires at least 1.5-2 cm of the renal artery before the first branching for a successful anastomosis.[2]

The analysis of the mean difference between renal artery caliber and the age of the subjects based on the research that has been done shown in Table 3 shows that the right renal artery caliber in subjects $\leq$ 40 years old (5.19 $\pm$ 0.53 mm) is greater than subjects > 40 years (4.58 $\pm$ 0 ,66mm). The same is true for the left renal artery. Statistically, it was found that there was a significant difference in the caliber of the right and left renal arteries by age category. Similar results were also found in Mohiudin's study in Pakistan. The study showed that there were statistical differences in the diameters of the right and left renal arteries by age group. With increasing age, the diameter of the renal artery will be smaller.[12] The results of this study were associated with a decrease in vascular size and an increase in blood vessel stiffness due to aging.[13,14] Based on age there was an average increase of 0.3 mm in diameter in both renal arteries visible after the age of 20 years and the diameter will be constant through the fourth and fifth decades of life. But then, there will be a decrease of 0.64 mm seen after the age of 50 years.[9,15]

The results of the study reported in South Africa, where the 0.4 mm increase in luminal diameter observed after the second decade remained almost constant until the fifth decade and a subsequent decrease of 0.4 mm until 60 years of age. Other studies have also been reported. strong influence of increasing age on renal artery diameter narrowing. The increase in diameter during adulthood may be due to increased physical activity and is associated with increased cardiac output. Meanwhile, the decrease in luminal artery diameter with age may be due to progressive thickening of the tunica intima, separation of individual elastic lamellae and increased collagen matrix in the arterial wall.[16,17]

Table 3 shows that the caliber of the right renal artery in male subjects (5.05 $\pm$ 0.69 mm) was greater than that of females (4.7 $\pm$ 0.60 mm). Likewise, the left renal artery was found in males (5.41$\pm$0.65 mm) and females (5.08$\pm$0.63 mm). Statistically, it was found that there was a significant difference in the mean of male

research subjects compared to women. According to Schoner's research, the diameters of the right and left renal arteries are statistically smaller in women than in men. Cross-sectionally it appears that the renal artery is usually slightly ellipsoidal, more prominent on the right than on the left. The implantation angle of the right renal artery is somewhat earlier with respect to the longitudinal axis of the aorta than that of the left renal artery.[8] The female left renal artery measures 4.7±1.4 mm compared to the male 5.6±1.2 in diameter and the diameter of the right renal artery in women was 4.5±1.0 mm compared to 5.2±1.3 in men. From this study, it was found that there was a relationship between gender and arterial diameter.[14,18]

In studies in countries such as Pakistan and Iran, it was found that statistically significant differences in the mean diameters of the right and left renal arteries were observed between men and women. A recent study was reported at the University of Virginia, where bilateral renal artery diameters were greater in men. compared to women. This size difference is due to the relatively large body size of men compared to women.[1,12] The increase in diameter in men may be due to higher physical activity of men than in women. This results in an increase in blood flow to a larger renal artery. [1,20]

A thorough knowledge of the morphological variations of the renal arteries is useful and relevant for kidney transplant surgery, uroradiological procedures, renovascular hypertension, renal trauma and hydronephrosis. Kidney anatomy describes each kidney drained by one renal artery. However, much of the current literature reports large variability in renal irrigation patterns. It should be emphasized that the renal artery number is the artery with the most frequent variation. The renal artery variation may number from 1 to 4 additional renal arteries.[14] This may be unilateral or bilateral. The location of the accessory arteries may be hilar, superior and inferior polar, according to the point at which they enter the renal parenchyma.[21] The renal ostium arteries are usually located lateral to and in front of the lateral aorta, posterolateral origin is less common. The renal arteries also show variations of other origin, in the form of variations in diameter, length and segmental distribution. All variations can be related to development during the embryological phase. The renal accessory artery has been reported in different population groups, with an incidence varying from 10% - 50%. The left renal accessory artery is the most frequently reported.[15,19]

In this study, 8 out of 60 research subjects had an accessory renal artery (13,2%). In another study, the proportion of renal accessory arteries was 24.9% in the Colombian population, in the Indian population (13.5%), the mestizo population (18.5%), Thailand (17%) and the black population (18%). Studies in Caucasian, African and Turkish populations have reported the highest proportion of 30% - 40%.[10] Differences in renal accessory artery frequency may be due to ethnic factors, type of study or the size of the sample being evaluated. Although there was a large difference in the increase in the number of accessory arteries between men and women, this difference was not statistically significant ($p = 0.317$). In Columbia it was reported that bilateral accessory arteries had been reported in 7.7% while unilateral accessory arteries were 4.7%.[10,15]

CONCLUSION

Patients who underwent CT-Scan Abdomen with intravenous contrast were 1789 people. Distribution by sex, 968 patients were women (54.1%) and the most age was > 40 years, namely 1239 patients (69.3%). There was a difference in the mean renal artery caliber between patients aged ≤40 years and > 40 years ($p<0.05$). And there is also a difference in renal artery caliber between male and female subjects who underwent abdominal CT Scan with intravenous contrast at HAM Hospital Medan.

CONSENT FOR PUBLICATION

The Authors agree to publication in Journal of Society Medicine.

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COMPETING INTERESTS

None.

AUTHORS' CONTRIBUTIONS

All authors significantly contribute to the work reported, whether in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas. Contribute to drafting, revising, or critically reviewing the article. Approved the final version to be published, agreed on the journal to be submitted, and agreed to be accountable for all aspects of the work.

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