Original Article

Measurement of Renal Arteries Using Multi detector Computed Tomography: A Study in Tertiary Care Hospital in Nepal

Khanal UP, Ansari M, Humagain M, Dhakal S.

Department of Radiology and Imaging, Institute of Medicine, Tribhuwan University Teaching Hospital, Kathmandu, Nepal.

Correspondence to: Assistant Prof. Dr. Umesh Prasad Khanal, Department of Radiology and Radiology and Imaging, Institute of Medicine, Tribhuwan University Teaching Hospital, Kathmandu, Nepal.

Email: upkhanal2007@gmail.com

Abstract

Introduction: The purpose of this study was to determine the dimensions of the renal arteries (length and diameter), among the patients referred for Contrast Enhanced CT(CECT) of abdomen in department of Radiology and Imaging, Tribhuwan University, Teaching Hospital.

Methods: This prospective study was performed in Department of Radiology and Imaging TUTH with A total of 135 (73 male and 62 female) patients underwent CECT abdomen from June to September 2018. In this study the diameter of right and left renal arteries, the length of right and left renal arteries were determined.

Results: The mean values of right renal artery diameter were found to be (0 .5706 ± 0.09861 cm) in males and (0.5061 ± 0.08384 cm) in females respectively. The mean values of left renal arteries diameter were found to be (0.5889 ± 0.10351 cm) in males and (0.5354 ± 0.10552 cm) in females respectively. The mean values of right renal artery length were found to be (4.568751 ± 0.83128cm) in males and (4.0318 ± 0.87575cm) in females respectively. The mean values of left renal arteries length were found to be (3.5990 ± 0.79567cm) in males and (3.2002 ± 0.59207cm) in females respectively. The diameter of renal artery diameter exhibited statistically significant differences in relation to age of the patients ($p<0.05$) with peak values in 55- 64 years age group where the mean right and left renal arteries diameters were found to be 5.801 mm and 6.012 mm respectively.

Conclusion: This study concluded that the diameter of the renal arteries varies significantly with the age of the patients.

Keywords: Multi detector computed tomography, renal artery dimensions

Introduction

The advent of Multi Detector Computed Tomography (MDCT) and advanced techniques of digital image reconstruction have provided an alternative means of performing angiography, without the risks inherent to invasive angiographic examinations. Computed Tomography Angiography (CTA) studies carry fewer risks compared to that of the digital angiography studies, with the advantage of evaluating not only the vascular lumina but also the vessel walls and other viscera, and is now used more frequently in various scenarios: Kidney transplant, Takayasu's disease, and Ureteropelvic Junction (UPJ) stenosis due to compression of the inferior polar artery [1]. MDCT plays crucial role in the detection of reno-vascular diseases, in particular renal artery stenosis. MDCT successfully describes the detail morphology of the renal arteries including caliber, length, plaque location, branching patterns and presence of accessory or polar arteries [2].

Knowledge about the dimensions of the renal vascular system is important for various conditions that require surgical planning and is crucial to the success of the

procedure. The incidence of End Stage Renal Disease (ESRD) is gradually increasing and renal transplant is considered as the best choice of treatment for these patients. It is essential for the surgeon to have complete renal vasculature information regarding the origin, diameter, length of renal arteries, for accurate renal assessment of each potential living renal donor to avoid complications. These information are also very important for guiding interventional radiologist during procedures like arterial catheterization and angioplasty[3]. Percutaneous arterial stenting is also the choice of treatment for renal artery stenosis, but this requires definite measurement of renal artery diameter and length [4].

Before the advent of MDCT, a renal living donors underwent radiographic evaluation with intravenous urography (IVU) and renal and aortic angiography. These techniques depicted of renal size, calculi, calcifications and anatomy of the collecting system and arteries however, renal masses, small lithiasis and venous anomalies were not properly assessed. For these reasons, the procedures have been replaced with MDCT since it offers unquestionable advantages [5]. CT angiography is less invasive, better tolerated by donors, and provides significantly more information than intravenous urography and angiography together, especially regarding abdominal anatomy and vascular pathways [6-8].

This study was performed to know the diameter and length of renal artries in Nepalese population. Since no data are available till date in literature regarding the dimensions of renal artries in Nepalese population. For the last decade renal transplantation is available in Nepal and specially regularly performed in TUTH this study might contribute to enrich knowledge about kidney, renal artries its variations and different measurements.

Methods

A total of 135 patients (62 females and 73 males) undergoing CECT Abdomen (triple phase) in Department of Radiology and Imaging, TUTH were selected. The selected patients had normal or near-normal renal function (serum creatinine concentration ≤2.0 mg/dl) and did not have any known history of renovascular disease, hypertension or had undergone nephrectomy or renal transplantation.

The examinations were performed as per the protocol of the department

CECT Protocol in TUTH (in Seimens Somatom Definition AS+ 128 slice) •600 ml plain water 30 minute before and then 400 ml just before examination.

- Scanning area from dome of diaphragm to iliac crest.
- Detector collimation: 0.6x128
- Pitch: 0.85
- Kv: 120
- mAs: 200
- Contrast: Intravenous.
- Volume: 80-100ml at rate of 3.5-4 ml/s
- Recon slice and interval: 5x5mm

Phase	Scan Delay or Bolus Tracking
Arterial Phase	18-20 sec
Portal Phase	45-55 sec
Venous Phase	65-70 sec

Measurement of the diameter and length of the renal arteries were made on axial sections of the image slices taken during the arterial phase by reconstructing the axial slices in thin section MIP images where thickness varied from (5-30mm).

Data Analysis

Statistical analysis was carried out with the help of SPSS version 23 and Microsoft Excel version 2013. P value less than 0.05 was considered as level of significance.

Result

A total of 135 patients were enrolled in this study. Among them 73(54.07%) of the patients were male and 62(45.92%) were female respectively (Figure.10). The mean age was 44.87±19.331 years .The range of age was 5-82 years.

The patients were divided into eight groups on the basis of age with a class width of 8 starting from 5 years to 82 years. The frequency distribution of the groups were as follows:

Age Groups	Frequency
5-14	6
15-24	17
25-34	24
35-44	18
45-54	18
55-64	22
65-74	24
75-84	6
Total	**135**

Table 1 showing the number of patients of each age group starting from 5 years to 84 years of age with interval of 9 years each. The highest number of patient included was 24 in age group 25-34 and 65-74. The least number of patient belong to 5-14 years and 75-84 years

Measurement	Mean Value in Males (cm)	Mean Value in Females (cm)	Mean Difference (cm)	Standard Deviation in Males (cm)	Standard Deviation in Females (cm)	P value
Right Artery Diameter	0.5706	0.5061	0.6446	0.09861	0.08384	0.56
Left Artery Diameter	0.5889	0.5354	0.5347	0.5347	0.10552	0.98
Right Artery Length	4.568751	4.0318	0.53631	0.53631	0.87575	0.934
Left Artery Length	3.5990	3.2002	0.39888	0.79567	0.59207	0.83

Age Groups	Mean Right Diameter (mm)	Mean Left Diameter (mm)
5-14	4.901	5.012
15-24	5.096	5.366
25-34	5.066	5.392
35-44	5.512	5.977
45-54	5.444	5.714
55-64	5.801	6.012
65-74	5.315	5.821
75-84	4.443	4.582

Diameter	Highest	Lowest	Mean	SD
Right renal artery	7.4mm	3.2mm	5.41mm	0.09728
Left renal artery	7.8mm	3.0mm	5.64mm	0.10743

Length	Highest	Lowest	Mean	SD
Right renal artery	6.43cm	1.98cm	4.32cm	0.7661
Left renal artery	5.79cm	1.64cm	3.41cm	0.73454

Table 2

Results

In this study the mean right renal artery diameter, the mean left renal artery diameter, the mean right renal artery length and the mean left renal artery length were determined. The mean values of right renal artery diameter were found to be (0 .5706 ± .09861 cm) in males and (0.5061± .08384 cm) in females respectively with a range of 0.74 cm to 0.32 cm. The mean values of left renal artery diameter were found to be (0.5889± 0.10351 cm) in males and (0.5354± 0.10552 cm) in females respectively with a range of 0.78 cm to 0.30 cm respectively. The mean values of right renal artery length were found to be (4.568751± 0.83128cm) in males and (4.0318± 0.87575cm) in females respectively with the range of 6.43 to 1.98 cm. The mean values of left renal artery length were found to be (3.5990± 0.79567cm) in males and (3.2002± 0.59207cm) in females respectively with the range of 5.79 cm to 1.64 cm.

In this study we found that the diameters of the left renal arteries were larger than the diameter of the right renal arteries. Similarly, the length of the right renal arteries were found to be longer than that of the left the renal arteries.

Discussion

Knowledge about the dimensions of the renal vascular system is important for various conditions that require surgical planning and is crucial to the success of the procedure. The knowledge about the dimensions of the renal arteries is crucial in cases of renal donors and conditions requiring surgical interventions. In depth knowledge is required in the cases of renal transplantation, arterial cathterization, angioplasty, for sympathetic renal denervation, percutaneous arterial stenting and to know about the role of renal artery diameter on atherosclerotic renovascular diseases that are generally associated with resistant hypertension and chronic kidney diseases [8].

The surgical prerequisites for undergoing transplantation has its own protocol and it varies between the institutes providing the transplant services. Computed Tomography is one of the most important preoperative investigation for donor selection as it has several advantages which include identification of anatomy and status of the kidneys including variations, renal vasculature variants which could result in severe complications during surgery. If it is not identified preoperatively also identification of pathologies involving other visceral organs is also crucial which may cause difficulty in transplantation.

There is paucity of data regarding the physiological ranges of renal artery diameter. Therefore, for the definition and classification of structural abnormalities, such as aneurysms, stenosis, etc, knowledge of normal renal artery diameter is quite essential [9].

The increase in the transverse diameter of the renal artery in early adulthood could be attributed to workload due to increased physical activity and associated increased cardiac output. Physiological changes occurring in early adulthood may also be implicated. Similarly, reduction in diameter at old age may be a consequence of senescence as old age leads to progressive thickening of the tunica intima layer as well as thinning and separation of individual elastin lamellae and an increase in the collagen matrix [8-9].

The results of our study showed that the peak values of the right and left renal artery diameters were observed in 55-64 years age group which were 5.801

and 6.012 mm respectively. Variations in the diameter of the renal arteries were found to be statistically significant with age but insignificant with gender. One way ANOVA test was done to study the significance of variance of renal artery diameter with age which resulted P =0.017(<0.05) i.e. statistically significant. This concluded that the diameters of the renal arteries vary with age

however the variation of the renal arteries with gender was found to be statistically insignificant with P=0.98 (P>0.05) showing no variations in the diameter of the renal arteries in both sexes..

Conclusion

Prior to donor nephrectomy, it is of paramount importance to perform CT Angiography to minimize the adverse complications during nephrectomy and diagnose other associated pathological conditions as incidental findings in other organs as contraindications to avoid inadvertent surgeries. Surgeons must have thorough knowledge of renal vasculature of the patients and should have necessary information of anomalies of renal vasculature on CTA prior to laparoscopic donor nephrectomy.

This study showed CT to be a reliable method for the measurement of different dimensions of the renal arteries. The result showed higher mean value of renal

arteries length and diameter in male than female and statistically significant differences among various age groups. The measurement of dimensions of the renal arteries can help both clinical and surgical situations The accuracy of MDCT in detection of the renal vascular anomalies has been well demonstrated in the literature, and it is widely employed for live kidney donor work-up. The application of MDCT has been growing increasingly because of its high sensitivity and specificity in identifying specific vessels, (99.6% and 99.6% respectively) for main renal arteries [8] and 100% specific in the diagnosis and detection of severe stenosis of the renal artery [1].

References

1. Mello Júnior C, Araujo Neto SA, Carvalho Junior AM, et al. Multidetector computed tomography angiography of the renal arteries: normal anatomy and its variations. Radiol Bras. 2016; 49:190-5.
2. Gümüş H, Bükte Y, Özdemir E, Çetinçakmak MG, Tekbaş G, Ekici F, Önder H, Uyar A. Variations of renal artery in 820 patients using 64-detector CT-angiography. Renal failure. 2012 Apr 1; 34(3):286-90.
3. Go AS, Chertow GM, Fan D, McCulloch CE, Hsu CY. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. New England Journal of Medicine. 2004 Sep 23; 351(13):1296-305.
4. Cantatore A, Müller P. Introduction to computed tomography. DTU Mechanical Engineering: Kongens Lyngby, Denmark. 2011; pp.7-9
5. Rydberg J, Kopecky KK, Tann M, Persohn SA, Leapman SB, Filo RS, Shalhav AL. Evaluation of prospective living renal donors for laparoscopic nephrectomy with multisection CT: the marriage of minimally invasive imaging with minimally invasive surgery. Radiographics. 2001 Oct;21(suppl_1):S223-36.
6. Urban BA, Ratner LE, Fishman EK (2001) Three-dimensional volume-rendered CT angiography of the renal arteries and veins: normal anatomy, variants and clinical applications. RadioGraphics 21:373–386
7. Kadir S (1986) Angiography of the kidneys. In: Kadir S (ed) Diagnostic angiography. Saunders, Philadelphia, pp 445–495
8. Aronberg DJ. Glazer HZ. Madsek K. Normal renal artery diameter by computed tomography. J of CAT, 2002; 8: 247-50
9. Miyawaki NB. Lester BE. Vascular disease in elderly. American Society of Nephrology.http://www.asnonline.org/education_and_meetings/distancelear ning/ curricula/ geriatrics/Chapter13.pdf. 2009. Accessed: May 2012
10. Mohiuddin M, Manzoor A, Ali M Hassan N. Analysis of renal artery morphometery in adults: A study conducted by using Multidetector computed Tomography Angiography. Pakistan journal of medical sciences. 2017 Jul; 33(4):943.