Int J Pharm Bio Sci 2016 Jan; 7(1): (B) 391 - 396

Original Research Article **Allied Science**

International Journal of Pharma and Bio Sciences **ISSN 0975-6299**

MEASUREMENT OF RENAL SIZE IN RELATION TO BODY HABITUS USING COMPUTED TOMOGRAPHY

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ABSTRACT

AIM: Measurement of renal size in relation to body habitus using computed tomography OBJECTIVES: To measure the renal sizes. To find the variation between age, gender and body mass index (BMI). METHODOLOGY: By using MDCT kidney length & width were measured on oblique coronal reformatted CT images of 93 patients who all received routine abdominal CT scan with no pathology associated with renal. The patients had normal creatinine levels, no history of renal disease, & normal-appearing on CT. patient weight, height, & gender were recorded. RESULT: The mean of LRT (length of right kidney) in males 94.6±7.45 SD and in females 96.82±7.73 SD. Mean of LLT (length of left kidney) in males 95.42±6.76 and in females 97.56± 6.88SD. Mean WRT (width of right kidney) in males 45.08 ± 5.0 and in females 46.73±4.50 SD and WLT (width of left kidney) in females 47.63 ± 4.95 SD, Keeping P-value of 0.05. There was no statistical significance difference between the renal size with body habitus also with age and gender. CONCLUSION: Normal renal size does not vary according to patient's body habitus. No relationship was found between renal sizes and age. Renal size is independent of the age and BMI. Similarly the gender also does not affect the renal size. Coronal section of abdominal CT predicts the renal length more accurately than any other imaging techniques, but all imaging techniques were always associated with small prediction errors. Further studies are possible with a larger sample size to find out the variation.

KEY WORDS: Kidney, volume measurement, computed tomography

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INTRODUCTION

Computed tomography (CT) is an excellent useful imaging tool and has significant advancement in field of radiology. An abdominal CT scan is a noninvasive imaging technique which involves specialized X-ray technique to capture radiographs of patients[1, 2]. A CT scan of abdomen can identify signs and degree of inflammation, effects of traumatic injury, infection, disease of gastro intestinal tract[3, 4]. Estimation of renal size is very important for assessment of renal disease clinically and also important for the treatment of the disease in the field of medicine[5]. The kidney dimension varies in a very huge extent from birth to adulthood[6]. Clinically the estimation of kidney is not widely used because renal measurement is very complicated due to the complex shape of kidneys[7]. The kidney length and volume are the important measurements used to estimate the kidney size, which helps clinicians to mainly differentiate between acute and chronic renal failure, so this helps to kidney transplant candidates, hence this provides a basis for therapeutic decisions for further procedures such as to take renal biopsies or not[8, 9]. Kidney transplantation is best treatment for final stage kidney disease. Therefore precise and accurate methods for assessment of kidney size are of great clinical importance on medicine [10, 11]. Ultrasound (US) and CT are most widely used to determine renal volume. With this variety of radiological modalities, kidney volume is calculated using the ellipsoid or voxel count methods[12, 13]. Although US is preferred for estimating renal length because it does not involves ionizing radiation, it is also not appropriate for estimation of renal volume because it is mainly associated with substantial intra and interobserver variation greatly [5]. The use of CT for accurate estimation of renal anatomy is most common[14, 15]. CT is more appropriate for estimation of renal volume than US because it produces multidirectional images with good quality and repeatability [5]. Many studies have used a simple method to estimate kidney volume by using magnetic resonance imaging (MRI) [16, 17]. Many studies have been done to analyze the diameters of kidney using CT and US[18, 19 and 20]. Especially MSCT have lot of importance in the estimation of renal morphology and also its vessels. The MSCT has a high spatial resolution and temporal resolutions; on the other hand, its main disadvantage is radiation exposure and the use of contrast medium [21].

MATERIALS AND METHODS

- ***Research design***: Observational study
- ***Research setting***: 64 slice brilliance MDCT Philips,Department Of Radio diagnosis and Imaging Kasturba hospital, Manipal
- ***Population***: Patient who is undergoing plain abdomen CT scans
- ***Sample size*** : 93 patients; (males , females)

$$\text{Formula: } n = \frac{z^2 x \sigma^2}{d^2}$$

Where,

n=Sample size

Z= 1.96

σ=SD of effective dose

d=Allowable error

$$\text{BMI}(kg/m^2) = \frac{\text{weight}(kg)}{\text{Height}^2\ (m)}$$

- ***Sampling technique***: Convenience sampling technique
- ***Sampling criteria***

Inclusion criteria: Age above 18 – 70 years and patient without renal pathology

Exclusion criteria: Patients for CECT (contrast enhanced CT)
Artifacts and technical defects of images
Trauma patient
Incomplete evaluation of the kidneys

METHODS

The study approval was acquired by the institutional research committee, SOAHS and Ethics committee KH. Considering the inclusion and exclusion criteria 93 samples were selected by convenience sampling technique, out of which 44 were males and 49 were female's patient with age ranging from 18-70 years whose CT scan abdomen was performed within the study period. Patient hospital number, age, gender, weight, and height are recorded. The CT scan of the patients was done in a standard abdomen protocol shown in Table 1. All the scans were performed on 64 Slice MDCT at Dept.

of Radio-diagnosis and Imaging, Kasturba Hospital, Manipal. After all the images acquired in 5mm thickness, then these images are reformatted in 1.4 mm thickness then images are transferred to Philips extended brilliance workspace. Images are displayed on the monitor, with the help of measuring scale in the monitor the kidneys volume were measured in mm and the measurements were noted in data sheet. The standard coronal reformatted images were tilted individually along the longitudinal axis for both left and right kidneys, with the help of reference line on the sagittal plane. The kidney length was measured from pole to pole and width measured in standard coronal plane and recorded shown in figure 3.

Table 1
Abdomens HelicalProtocol

Protocol/mode	Abdomen Helical
Patient position	Supine – feet first
Scano	180˚
FOV	350 mm
Area coverage	Domes of diaphragm- symphysis pubis
Scan direction	Cranio caudal
KVp	120
MAs	250
Slice thickness	5 mm
Increment	5 mm
Resolution	Standard
Collimation	64 x 0.625
Pitch	0.984
Rotation time	0.75sec
Filter	Standard (C)
Matrix	512X512

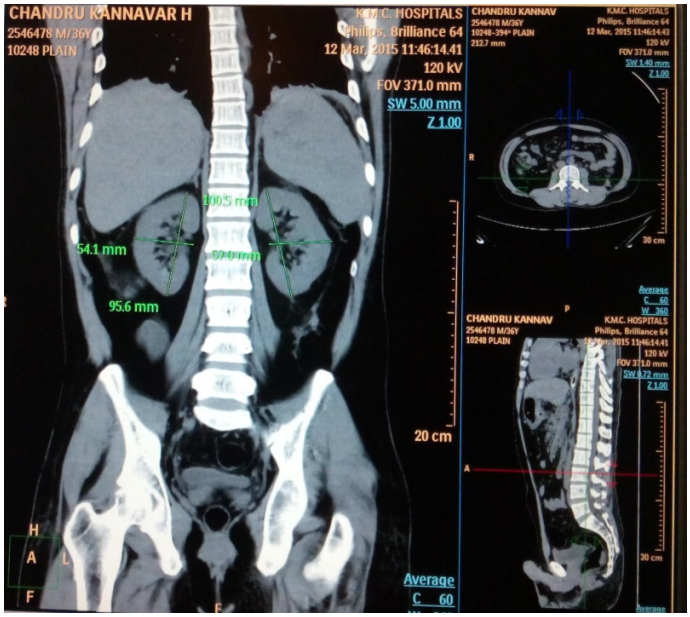

Figure 3
Length and width of right and left kidney were measured

RESULTS

The kidney measurements were collected for 93 subjects among which were 44 male samples and 49 female samples, with the age group of above 18 -70 years respectively. Contrast enhanced CT cases was excluded from the study. The kidney length measured from pole to pole and width of left and right kidney were measured and the values analyzed using SPSS16, performed a group statics, which is given in the

Table3
Group statistics

	Gender	N	Mean	Std. Deviation
LRT	MALE	44	94.6614	7.45667
	FEMALE	49	96.8245	7.73481
LLT	MALE	44	95.4205	6.76027
	FEMALE	49	97.5653	6.88179
WRT	MALE	44	45.0886	5.01153
	FEMALE	49	46.7367	4.50161
WLT	MALE	44	46.3523	5.38441
	FEMALE	49	47.6347	4.95877

The mean of LRT (length of right kidney) in males 94.6±7.45 SD and in females 96.82±7.73 SD. Mean of LLT (length of left kidney) in males 95.42±6.76 and in females 97.56± 6.88SD. Mean WRT (width of right kidney) in males 45.08 ±5.0, and in females 46.73±4.50 SD. And WLT (width of left kidney) in females 47.63 ± 4.95 SD. Performing independent test keeping P-value of 0.05, we found that the P-value was 0.343 was greater than 0.05 so, there was no statistical significance difference between the renal size with body habitus also with age and gender showed in the table.

Table 4
Independent samples test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
LRT	Equal variances assumed	3.643	.059	-.954	91	.343	-238.47110	250.09930
	Equal variances not assumed			-1.007	48.002	.319	-238.47110	236.86368
LLT	Equal variances assumed	4.501	.037	1.041	91	.301	197.38015	189.62977
	Equal variances not assumed			.986	43.004	.330	197.38015	200.23832
WRT	Equal variances assumed	4.483	.037	1.054	91	.294	110.36206	104.66272
	Equal variances not assumed			.999	43.005	.324	110.36206	110.51777
WLT	Equal variances assumed	2.299	.133	-1.434	91	.155	-2.33530	1.62879
	Equal variances not assumed			-1.461	85.962	.148	-2.33530	1.59854

DISCUSSION

Renal sizes are very important in the evaluation of kidney disease for both clinicians and as well as radiologists[3]. And also accurate evaluation of renal sizes is important because it is more useful in the index of nephron and filtration[5]. There are many studies performed where kidney volume measurements were considered by using ultrasound, but CT scan is more reproducible and also fewer operators dependent. The standard coronal planes of reformatted CT scans were used in kidney measurement purpose but this method was previously proven to be the most accurate way in medical imaging[3]. And also few studies were reported by analyzing both US and MR imaging to find kidney volume repeatability[26]. And some studies were reported with comparison of dynamic study of SPECT by using Tc99m and computed tomography to evaluate renal volume[27]. Several similar studies were performed in other countries, but only few studies were reported in India. Werner S Harmse[3]performed study to find out the normal variations in kidney size in relation with the body habitus with the use of 514 samples. The main purpose was to assess the relationship of kidney sizes to race and gender. He found 108mm of mean renal length with 9.82 SD. His study reported that kidneys were smaller in black population, and larger in white population, and also male renal sizes are larger than in females. They concluded that normal kidney size varies according to body habitus. In the present study we found that there was no relationship with renal sizes with body habitus. Ho Sik Shin[10], et al performed a study of renal volume measurement in young Korean using MDCT. They viewed 113 young Korean mean patient's data in the study. After collecting body parameters of all patients, they measured the renal volume and length. They correlated body parameters with volume and length of kidney and found that there were weak correlations with all body indexes, similar to the present study. And they concluded their study that the measurement of renal volume with MDCT is useful in clinical field. Hyeon Seok Hwang[5], et al performed the study of direct measurement of renal size in renal donors by noninvasive technique. They considered 139 renal donors which were evaluated in the study. The renal length was evaluated using US and CT. They measured renal volume in CT with the help of ellipsoid and voxel count technique. They found that CT estimation of renal length is more accurate compare with US, similar to our study where CT estimations of renal length is very less operator dependent and is also an easy method of measuring the renal length.KangKY[28], et al performed a comparative study to evaluate renal

length in renal transplantation donors. 125 subjects donors were considered, the renal length were estimated by using both US and CT. They calculated correlation with renal volume and body indexes. Their study concluded that by using coronal abdominal CT section was more accurately predicted renal length than with any other imaging methods, but also showed that all imaging methods were always associated with small prediction errors. Similar to present study where radiological methods are always an easy method to estimate the renal volume and it has always shows some small measurement errors. And their study concluded that body index is more useful and also simplest method to evaluate renal size. Present study showed that there was a wide range in renal sizes and we found that there was no significant association between kidney size, BMI and age. There was no variation in renal size with gender. The evaluation of kidney size with the help of computed tomography is one of the non-invasive method and easy estimation of kidney measurements in medical imaging.

CONCLUSION

By using plain abdominal CT, a simple method of estimation of renal volume, our study concluded that a normal renal size does not vary according to patient's body habitus. No relationship was found between renal sizes and age. Renal size is independent of the age and BMI. Similarly the gender also does not affect the renal size. Coronal section of abdominal CT predicts the renal length more accurately than any other imaging techniques, but all imaging techniques were always associated with small prediction errors. Further studies are possible with a larger sample size to find out the variation.

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