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Original Research Article

RENAL DIMENSIONS MEASUREMENTS: ACCURACY AND REPEAT-ABILITY OF SONOGRAPHIC COMPARED WITH THAT OF 64-SLICE MULTIDETECTOR COMPUTED TOMOGRAPHY

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ABSTRACT

Renal size like length measured by ultrasound and volume measured by CT could be used to monitor the progress of chronic kidney diseases. Multi-Slice Computed Tomography (MSCT) has a growing importance in the evaluation of Kidney morphology and its vessels. But there is a risk of contrast media-induced nephropathy and exposure to radiation. Volume measured by CT is better than the length measured by CT.

KEY WORDS - Computed Tomography, Radiation, Renal size, ultrasound

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INTRODUCTION

The bean shaped kidneys filter plasma of blood & excrete metabolic waste products. Serum creatinine level is conventionally used to know the function of kidney. It provides combined function of both kidneys, and also depends on the individual's nutritional status & muscle mass [1]. It does not provide any information of unilateral renal disease. Decreased kidney size is associate with stenosis of renal artery [2]. Hence renal size & renal function combinedly will provide better information of wellbeing of kidney. Intravenous Pyelogram, ultrasonography, computed tomography and magnetic resonance imaging are modalities for estimating kidney size and function [3] Renal size like length measured by ultrasound and considering the complexity of the kidney shape the volume measured by CT could be used to monitor the progress of chronic kidney diseases [4]. Abdominal CT permits accurate cross-sectional radiographic visualization of visceral organs. Especially Multi-Slice Computed Tomography (MSCT) has a growing importance in the evaluation of Kidney morphology and its vessels [5]. Renal volume assessed by serial slices CT renal volume have been shown to be a reliable, reproducible method [6].

MATERIALS AND METHODS

The present study was conducted in KIMS, Bhubaneswar on 155 subjects. The aim of the study was to compare the measurements of kidney parameters by ultrasound & Multi-Slice

Computed Tomography (MSCT). First ultrasound was performed for the subjects who were referred for CT examination. All ultrasound examinations were performed on a Siemens Acusion x-300 and Volusion Pro 730 (GE) ultrasound machine using curvilinear 2-5 MHz or linear 5–10-MHz probes. After locating the Kidney, the transducer was rotated slightly to determine the longest renal axis and the renal length was measured as the maximum bipolar dimension in longitudinal plane which was displaying better Central Sinus Echoes, with the renal parenchyma evenly distributed around the Central Sinus (fig I & II). The transducer was then rotated 90° to the longitudinal axis and the Transverse Section was obtained at the level of the renal hilum for measuring the thickness (maximum antero-posterior diameters) & width or breadth (measurement from lateral to medial border). The renal volume (cm^3) was calculated from length, breadth & thickness by ellipsoid formula as

Renal volume = 0.523 × Length (in cm) × Width (in cm) × Thickness (in cm)

The same parameters were measured by CT examinations of the abdomen and pelvis on a GE Optima CT 660, 64 slice Scanner using Omnipaque IV contrast agent. Images were acquired helically at 5 × 5 mm slice thickness. The data were reconstructed at 0.625 mm to create 3 × 3 mm coronal images. Selected Coronal images were used as the basis for the Multiplanar Reformat Tool to reconstruct Oblique coronal images in the long axis of the Kidney (fig III & IV). Imaging was performed in nephrographic phase of contrast.

Fig. 1: Showing the Ultrasonographic measurements of left kidney of 23 years females.

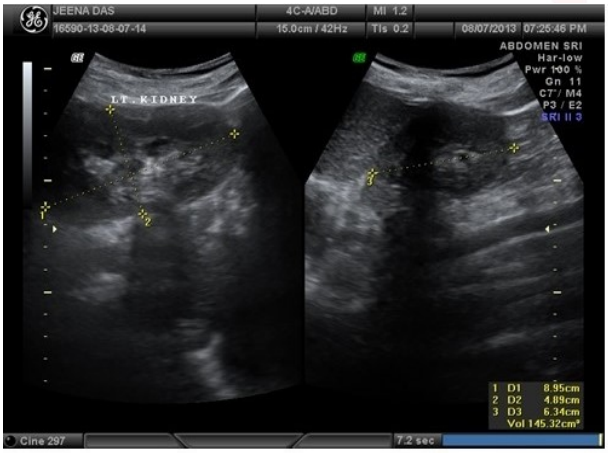


Fig. 2: Showing the Ultrasonographic measurements of Right kidney of 23 years females.

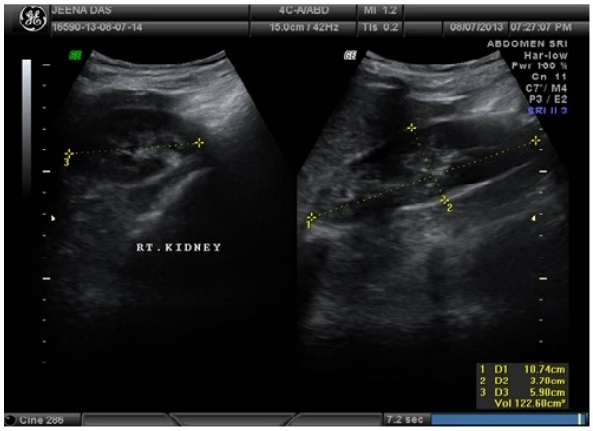


Fig. 3: Showing the right and left kidney length by computed tomography of 45 years males.

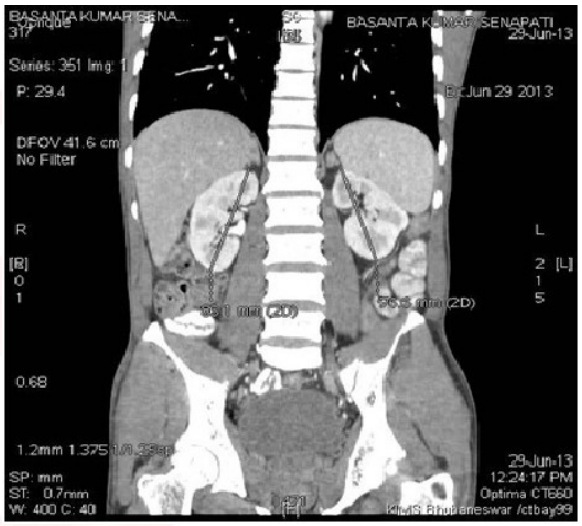
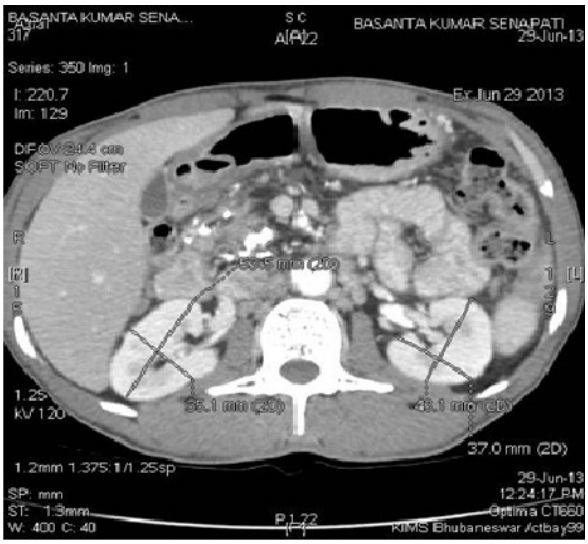


Fig. 4: Showing the right and left kidney breadth and thickness by computed tomography of 45 years males.



RESULTS

Data analysis was done by using software SPSS 13 version. The purpose was to see the difference in the measurements through the two procedures. This was compared with the help

Table 1: Comparison of parameters of Kidney measured through CT and USG.

	Parameters	Mean	N	Std. Deviation	Std. Error Mean	t value	p value
Pair 1	Length Right Kidney (CT)	96.127	155	9.009	0.724	2.175	0.031
	Length Right Kidney (USG)	94.951	155	10.026	0.805		
Pair 2	Breadth Right Kidney (CT)	45.736	155	10.686	0.858	5.152	0
	Breadth Right Kidney (USG)	43.126	155	10.283	0.826		
Pair 3	Thickness Right Kidney (CT)	43.998	155	6.93	0.557	3.488	0.001
	Thickness Right Kidney (USG)	42.661	155	7.039	0.565		
Pair 4	Volume Right Kidney (CT)	100.85	154	31.992	2.578	8.254	0
	Volume Right Kidney (USG)	91.499	154	30.218	2.435		
Pair 5	Length Left Kidney (CT)	98.026	155	10.823	0.869	-0.575	0.566
	Length Left Kidney (USG)	98.386	155	10.708	0.86		
Pair 6	Breadth Left Kidney (CT)	45.383	155	10.018	0.805	4.468	0
	Breadth Left Kidney (USG)	43.637	155	9.28	0.745		
Pair 7	Thickness Left Kidney (CT)	44.515	155	7.389	0.594	3.797	0
	Thickness Left Kidney (USG)	42.961	155	7.451	0.598		
Pair 8	Volume Left Kidney (CT)	104.439	153	36.899	2.983	4.764	0
	Volume Left Kidney (USG)	97.367	153	33.438	2.703		

of Paired 't' test. The results are tabulated in Table 1 and graphically represented in Figure V and Figure VI for right and left kidney respectively. It was found that length, breadth, thickness and volume of right kidney was measured to be higher by CT than USG with significant p value < 0.05. Similarly, for left kidney all the parameters except the length as measured by CT was found to be higher than that measured by USG (p = 0.000). The mean length of left kidney measured by CT and USG were 98.0 mm, 98.3 mm respectively &the difference is not significant statistically (p = 0.566).

Fig. 5: Comparison of parameters of Right Kidney measured through CT and USG.

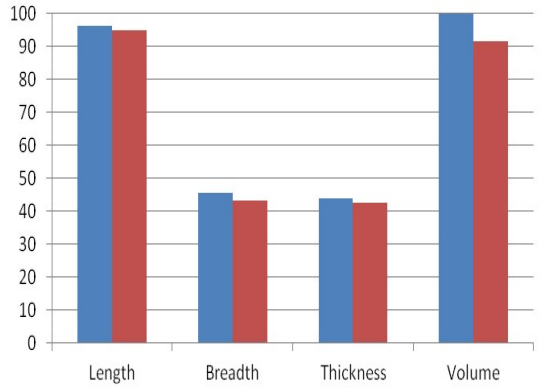
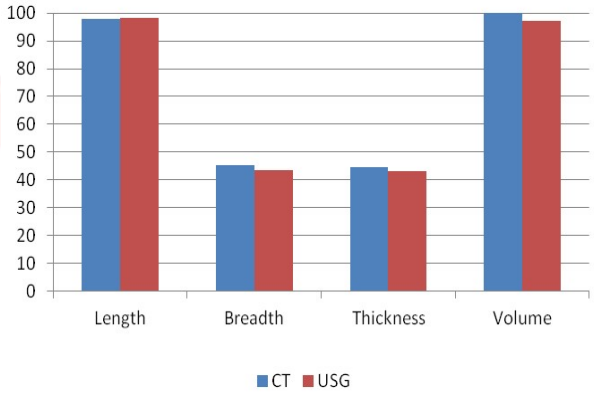


Fig. 6: Comparison of parameters of left Kidney measured through CT and USG.



DISCUSSION

The morphology of the kidney and the surrounding structures can be better visualized by Computed tomography than ultrasound examination. CT can evaluate the kidney vasculature noninvasively. The disadvantages of MSCT are radiation exposure and the dependence on contrast medium [5]. A reduction in renal length 8.5 cm or less indicates irreversible disease [7]. The renal parenchymal volume is the more exact ultrasonographic parameter in End-stage renal failure [8]. When the renal length is 8–9 cm at USG,CT/ MR imaging could be used to

Widjaja E. et al has reported CT measured renal volume to be a better predictor of Single Kidney GFR than ultrasound measured renal length[10,11]. Bakker et al[9] found CT renal length to be weakly correlated with renal volume (r=0.36) whereas Widjaja E et al found a signiûcantly higher level of correlation (r=0.86).

Table2: Percentage distribution of difference of measurements of Length and volume by CT and USG.

	Right	Left
CT length > USG length	73.55%	87.66%
USG length > CT length	25.81%	11.69%
CT length = USG length	0.65%	0.65%
Total	**100%**	**100%**
CT volume > USG volume	87.10%	83.90%
USG volume > CT volume	11.60%	16.10%
CT volume = USG volume	1.30%	0.00%
Total	**100%**	**100%**

The Percentage distribution of measurements of kidney length and volume by CT and USG of this study is depicted in table -2. In this study, all the parameters of both the kidneys measured by CT were larger than those measured by USG, except left kidney length, and were statistically significant (pd”0.05). Out of 155 subjects, the length of left kidney measured by CT was larger than that measured by USG in 87.66%. The difference between the measurement of mean lengths of the left kidney by CT and USG were not statistically significant (p=0.566). The lengths of right kidney as measured by CT were larger than those measured by USG in 73.55%.

The volume measured by CT was larger than USG measurements by 87.1% on right kidney and 83.9% on left kidney. Hence, volume measured by CT is better than the length measured by CT.

In this study, CT measured right kidney mean length to be 96.1± 9 mm; mean width to be 45.7±10.7 mm, mean anteroposterior diameter 43.9±6.9 mm and volume 100.9±31.9 cm^3. Left kidney mean length is 98± 10.8mm; mean width 45.4±10 mm, mean anteroposterior diameter 44.5±7.4 mm and volume 104.4±36.9 cm^3.

For all ages and all subjects by David B. Larson et al(2011), the mean renal length by CT was 93.2 mm for the right kidney and 96.2 mm for the left kidney, a combined mean was 94.7 mm, which is similar to this study[12].

In the study by Selma Uysal Ramadan et al(2011) the mean kidney dimensions were, length 108±11.3 mm, width 49.1±6.2 mm and antero-posterior diameter 47.1±5.8 mm[13]. Werner S. Harmse et al (2011) also in South African population study found, mean renal length by CT to be 108.2±9.82 mm[14].

Using non-enhanced Multidetector CT, Fei Gaoo et al (2011) determined normal values for a Chinese populatin for kidney length 10.27±1.01 cm for men & 9.93±0.81 cm for women. These values were smaller than previously reported MRI measurements[15]. The mean kidney length measured with Multidetector CT by Ho Sik Shin was 10.8 ± 0.69 cm and the mean kidney volume was 205.29 ± 36.81 cm3 in young Korean men. They demonstrated that kidney volume is a better indicator of body parameters and predictor of renal function than kidney length, thus suggesting that kidney volume is more useful than kidney length in clinical field in young Korean men[16]. Wolpert SM has shown that the kidneys slightly increase in size after IV administration of contrast agent[17, 18].

David B. Larson et al also noted that in complete abdominal ultrasounds, the maximum value slightly underestimate renal length compared with that obtained by CT but in dedicated renal ultrasounds, on an average, the maximum value slightly overestimate renal length compared with that obtained by CT[17].

Hyeon Seok Hwang found CT estimated kidney length to be more accurate than ultrasound estimated and CT estimated kidney volume using the Voxel count method was most useful to predict kidney weight[19].

Kiw-Yong Kang in their study, comparison with actual lengths of kidneys, showed that Ultrasound tends to underestimate kidney size. This result corresponds with the study by Hyeon Seok Hwang and the present study [19]. The accuracy of length wise measurements was better with coronal CT sections than with transverse CT sections or ultrasound. Furthermore, fat within the kidneys is not included in CT estimates of length, resulting in underestimation of kidney length [3, 11].

CONCLUSION

There are only few studies for comparison of

renal parameters between CT and Ultrasound. In this study CT measured right kidney mean length to be 96.1 ± 9 mm; mean width to be 45.7 ± 10.7 mm, mean anteroposterior diameter 43.9 ± 6.9mm and volume 100.9 ± 31.9 cm^3. Left kidney mean length was 98 ± 10.8mm; mean width 45.4 ± 10 mean anteroposterior diameter 44.5 ± 7.4 mm and volume 104.4 ± 36.9 cm^3.

While comparison between CT scan measured parameters with ultrasound (USG) measured parameters was done, it was found that the measured mean length, breadth, thickness and volume of right kidney were higher by CT scan than ultrasound with significant p value < 0.05. Similarly, for left kidney all the parameters except the length as measured by CT scan were found to be higher than that measured by USG with significant p value < 0.05. For the length of left kidney there is no significant difference in measurements of USG and CT scan (p = 0.566). Out of 155 subjects, the CT measured length of kidney was larger than that measured by USG in 87.66% and 73.55% on left and right kidney respectively. The volume measured by CT was larger than USG measurements by 87.1% on right kidney and 83.9% on left kidney. In this study all the dimensions of measured by ultrasound were underestimated than measured by computed tomography. In conclusion CT measured parameters will be more helpful for clinical practice.

ABBERVIATIONS

CT- computed tomography,

USG- Ultrasonography,

MSCT- Multi sliced computed tomography,

MRI - magnetic resonance imaging

Conflicts of Interests: None

REFERENCES

1. Morgan DB, Dillon S, Payne RB. The assessment of glomerular function: creatinine clearance or plasma creatinine? Postgrad Med J 1978;54:302.
2. Schreiber MJ, Pohl MA, Novick AC. The natural history of atherosclerotic and fibrous renal artery disease. Urol Clin North Am 1984;11:383–92.
3. Kang Kiw-Yong, Young Joon Lee, Soon Chul Park, Chul Woo Yang, Yong-Soo Kim, In Sung Moon, Yong Bok Koh, Byung Kee Bang, Bum Soon Choi. A comparative study of methods of estimating kidney length in kidney transplantation donors. Nephrol Dial Transplant 2007;22:2322–2327.
4. Kotre CJ, Owen JP. Method for the evaluation of renal parenchymal volume by X-ray computed tomography. Med Biol Eng Comput 1994;32:338–41.
5. Surcel C., Mirvald C., Gingu C., Andreea Udrea, Carmen Savu, I. Sinescu. Morphological aspects of the kidney: can normality be predicted? Rom J Morphol Embryol 2011;52(4):1325–1330.
6. Yokoyama M, Watanabe K, Inatsuki S, Ochi K, Takeuchi M. Measurement of renal parenchymal volume using computed tomography. J Comput Assist Tomog 1982;6:975–7.
7. Hekmatnia A., M. Yaraghi. Sonographic Measurement of Absolute and Relative Renal Length in Healthy Isfahani Adults Journal of Research in Medical Sciences 2004;2:54-57.
8. Otiv A., K Mehta, U Ali and M Nadkarni. Sonographic Measurement of Renal Size in Normal Indian Children. Indian Paediatrics. 2012;1-4.
9. Bakker Jeannette, Marco Olree, Robert Kaatee, Eduard E. de Lange, Karel G. M. Moons, Jaap J. Beutler, Frederik J. A. Beek. Renal Volume Measurements: Accuracy and Repeatability of US Compared with that of MR Imaging. Radiology 1999;211:623-628.
10. Gong In Hyuck, Jinho Hwang, Don Kyung Choi, Seung Ryeol Lee, Young Kwon Hong, Jae Yup Hong, Dong Soo Park and Hwang Gyun Jeon. Relationship among Total Kidney Volume, Renal Function and Age. The Journal of Urology 2012;187:344-349.
11. Widjaja E, Oxtoby JW, Hale TL, Jones PW, Harden PN, McCall IW. Ultrasound measured renal length versus low dose CT volume in predicting single kidney glomerular filtration rate. Br J Radiol. 2004;77:759–764.
12. Larson David B., Mariana L. Meyers and Sara M. O'Hara. Reliability of Renal Length Measurements Made With Ultrasound Compared With Measurements From Helical CT Multiplanar Reformat Images. 2011;196(5).
13. Ramadan Selma Uysal, Hasan Yigit, Dilek Gökharman, Isil Tunçbilek, N. Anil Dolgun, Pinar Kosar, Ugur Kosar. Can renal dimensions and the main renal artery diameter indicate the presence of an accessory renal artery? A 64-slice CT study Diagn Interv Radiol 2011;17:266-271.
14. Harmse Werner S. Normal variance in renal size in relation to body habitus. South African Journal of Radiology, 2011;15(4):123-126.
15. Gao Fei, Mei Yang, Chun Li Luo, Hua Pang, Xiao Hou Wu. Normal values for renal parenchymal volume and kidney length as measured by non-enhanced multidetector spiral computed tomography. Acta Radiologica 2011;52:686–691.
16. Shin Ho Sik, Byung Ha Chung, Sang Eun Lee, Woo Jin Kim, Hong Il Ha, Chul Woo Yang. Measurement of Kidney Volume with Multi-Detector Computed Tomography Scanning in Young Korean. Yonsei Med J. 2009;50(2):262–265.
17. Larson David B., Mariana L. Meyers and Sara M. O'Hara. Reliability of Renal Length Measurements Made With Ultrasound Compared With Measurements From Helical CT Multiplanar Reformat Images. 2011;196(5).

18. Wolpert SM. Variation in kidney length during the intravenous pyelogram. Br J Radiol 1965;38:100–103. Cited by Larson David B. et al. AJR, 2011.
19. Hwang Hyeon Seok, Hye Eun Yoon, Joo Hyun Park, Ho Jong Chun, Cheol Whee Park, Chul Woo Yang, Yong Soo Kim, Bum Soon Choi. Noninvasive and Direct Measures of Kidney Size in Kidney Donors. American Journal of Kidney Diseases, 2011;58(2):266-271.
20. Ninan V. T., K. Thomas Koshi, M. M. Niyamthullah, C. K. Jacob, G. Gopalakrishnan, A. P. Pandey , J. C. M. Shastry. A Comparative Study of Methods of Estimating Renal Size in Normal Adults. Nephrol. Dial. Transplant. 1990;5(10):851-854.

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