

Ultrasonographic estimation of kidney size in adult Bangladeshi population without known renal disease: a preliminary report

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ABSTRACT

Background: The kidney size of a patient is a valuable diagnostic parameter in clinical practice. Renal size varies with age, gender, body mass index (BMI), pregnancy, race and co-morbid conditions like diabetes mellitus (DM) and hypertension (HTN). Measurements of renal dimensions can be carried out by using different modern techniques like ultrasonography (USG), computed tomography (CT) scan and magnetic resonance imaging (MRI). Out of these modalities USG is choice because of its simplicity, inexpensive, easily available, non-invasive and easy reproducibility. There is no established nomogram for renal size in the Bangladeshi population. Aim of the study was to determine the ultrasonographic renal size in adult Bangladeshi population with no known renal disease and to correlate renal size with age, gender and BMI. In addition, we assess whether hypertension and diabetes mellitus affect renal size.

Methods: This cross-sectional study was done in BIRDEM General Hospital and included 55 patients with age >18 years over 6 month period. Study population were not known to have renal disease documented by urine routine microscopy, spot urine for albumin creatinine ratio (ACR), serum creatinine and USG. Their body weight, height and BMI were calculated along with duration of DM and HTN. Analysis was done for differences due to age, gender and laterality. The correlation of renal dimensions with anthropometric parameters were also done.

Results: A total of 55 patients were analyzed. There were 19 (34.5%) male and 36 (65.5%) female. The mean age was 46±10 years. Their mean weight, height and BMI were 61 ± 11 kg, 1.54±.069 meter, 25.7 ± 4.8 kg/m² respectively. In total population 34.5% (19) were diabetic and 32.5% (18) were hypertensive. The means of length, width and parenchymal thickness (PT) of right kidneys (RK) were 10.1 ± 0.87, 4.2 ± 0.67 and 1.4± 0.32 cm respectively. The means of length, width and PT of left kidneys (LK) were 10.3 ± 0.89, 4.5 ± 0.49 and 1.5 ± 0.32 cm respectively. Measurements were significantly higher in LK than those of RK respectively ($p=.003$, $p<.001$ and $p=.041$). There were significant differences in kidney length and PT between sex and age. There were also significant differences in kidney length and PT between subjects of higher BMI, long duration of DM and HTN. The correlation between renal length and weight showed a positive correlation ($r = 0.16$, $p < 0.023$).

Conclusion: The variation of parameters of both kidneys varies on gender, age, obesity, comorbidity like DM & HTN and with their duration. Length of both kidneys depends on body weight. Further study needed with large samples.

Key words: anthropometric variables, kidney length, parenchymal thickness, renal ultrasound, Bangladeshi Population.

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INTRODUCTION

Renal size is an important parameter used in the diagnosis and follow up of renal diseases. Renal dimensions, especially length and volume are considered surrogates for renal status in routine clinical evaluations.¹⁻³ Measuring kidney size using ultrasonography (USG) is established as a reliable method in most clinical settings.⁴⁻⁶ USG has been shown to have good accuracy as well as inter- and intra-observer reproducibility for renal length measurement⁷⁻¹¹ and a good correlation with different anthropometric variables.^{8,12,13} Renal volumes are commonly calculated from the renal ultrasonographic dimensions^{1,6,9,11-14} but a few studies have shown a significant underestimation of true volumes using this method with more reliable methods being computed tomography (CT) and magnetic resonance imaging (MRI).^{1,14,17} Despite this, ultrasonographic renal size estimation remains popular due to its availability, ease of performance, absence of requiring contrast media or ionizing radiation, less cost and reproducibility.

Renal size depends on different factors, including age, gender, body weight and body mass index (BMI).¹⁸⁻²¹ Renal size is also affected by co-morbid conditions like diabetes mellitus (DM), hypertension (HTN) and pregnancy.²² Ethnic differences, perhaps partly due to the above variables, are also expected to have influence in renal size.^{4,5,9,23,24} Data on normal ranges for renal dimensions are available from western literature^{1,8,25} and only limited data are available from Bangladeshi population. Estimation of normal renal size is very important on clinical decisions like renal failure determination, decision regarding renal biopsy and many other issues. So, it is imperative to have benchmark parameters in Bangladeshi population. We plan to undertake this study to collect preliminary nomographic data on renal dimensions done by USG in healthy Bangladeshi adults.

METHODS

This cross-sectional study recruited patients who attended in Radiology and Imaging Department of BIRDEM General Hospital for USG for health screening or non-renal purpose. Inclusion criteria were those who were healthy adult without known renal disease and age above 18 years. Pregnant patients and post transplant kidney patients were excluded from study.

The study protocol was approved by the Ethical Review Committee (ERC) of the Diabetic Association of Bangladesh (BADAS) (BADAS-ERC/EC/23/482).

Data collection

Patients were counseled regarding the purpose of the study in detail and if they agreed, after having the informed written consent, they were enrolled. Then his/her renal dimensions (length, width and cortical thickness in millimeters) were noted during USG or after the procedure from record/file. All USG were performed by two experienced Radiologists to exclude inter-observer variation. Other reports including serum creatinine, urine routine and microscopic examination and spot urine for albumin creatinine ratio (ACR) were collected from patients' records which were done as part of routine management. Their body weight, height, BMI and blood pressure (BP) were recorded. In diabetic patients their duration of DM were also recorded.

Statistical analysis

Data were analyzed by using Statistical Package for Social Sciences (SPSS) version 20. P value was considered significant as $P < 0.05$. Data were analyzed for mean, standard deviation, percentage; independent sample T test was done to determine the level of significance. Regression curve estimation was performed to observe the correlation between the renal length and body weight. Differences between the left and right renal parameters were analyzed using the paired student t-test.

RESULTS

A total of 55 patients were analyzed. There were 19 (34.5%) male and 36 (65.5%) female subjects. The age ranged from 27 to 71 years with mean 46.10 years. Diabetic populations were 19 (34.5%) and their mean duration of DM was 8 ± 5 years. Hypertension was present among 18 (32.5%) patients and rests were normotensive (Table I). Mean body weight of study populations were 61 ± 11 Kg and BMI was 25.7 ± 4.8 kg/m² (Table II).

Mean length of right kidney (RK) was 101.38 ± 8.76 mm and mean length of left kidney (LK) was 103.91 ± 8.98 mm. The mean widths of RK was 42.91 ± 6.79 mm and mean width of LK was 45.67 ± 4.91 mm. The parenchymal thickness (PT) of RK was 14.80 ± 3.25 mm and LK was 15.65 ± 3.20 mm (Table III).

Table I. Sociodemographic characteristics of the study subjects (N = 55)

Characteristics (mean±SD)/(number)	Values
Age (years)	46.33±10.22
Male/Female	19 (34.54%)/36 (65.45%)
Diabetes mellitus (DM)	19 (34.5%)
Duration of DM (years)	8.26±5.93
Hypertension (HTN)	18 (32.5%)
Duration of HTN (years)	6.06±4.86

Table II. Anthropometric characteristics of the study subjects (N = 55)

Characteristics (mean±SD)/(number)	Value
Systolic blood pressure (mmHg)	151.09±46.70
Diastolic blood pressure (mmHg)	80.00±7.99
Height (cm)	1.54±.069
Weight (kg)	61.16±11.74
BMI (kg/m ²)	25.77±4.86

Table III. Renal features of the study subjects (N=55)

Characteristics (mean±SD)/(number)	Values
RK length (mm)	101.38±8.76
RK width (mm)	42.91±6.79
Right renal parenchymal thickness (mm)	14.80±3.25
LK length (mm)	103.91±8.98
LK Width (mm)	45.67±4.91
Left renal parenchymal thickness (mm)	15.65±3.20

The mean±SD length (mm), width (mm), parenchymal thickness (mm) and cortical thickness (mm) of right and left kidney has been shown in Table IV. The length (mm), Width (mm) and parenchymal thickness (mm) of left kidney were significantly higher than those of right kidney respectively.

Table IV. Right and left kidney comparison of the study subjects (N = 55)

Characteristics (mean±SD)/(number)	Right kidney	Left kidney	P Value
Length (mm)	101.38±8.76	103.91±8.98	.003*
Width (mm)	42.91±6.79	45.67±4.91	<.001*
Parenchymal thickness (mm)	14.80±3.25	15.65±3.20	.041*
Cortical thickness (mm)	7.35±1.08	7.96±1.94	.056

While comparing the gender distribution length (mm) and width (mm) of the left kidney were significantly higher among female than those of their counterparts (Table V). While comparing the age group <50 years

and ≥50 years then we found that width (mm) of the left kidney was significantly bigger among younger subjects than older (Table VI).

Table V. Gender wise distribution of the study subjects (N = 55)

Characteristics (mean±SD)/(number)	Male N = 19	Female N=36	P Value
RK length (mm)	100.84±6.82	101.67±9.71	.155
RK width (mm)	44.68±7.09	41.97±6.53	.940
Right renal parenchymal thickness (mm)	14.34±3.91	15.05±2.87	.617
LK length (mm)	103.00±5.50	104.39±10.40	.035*
LK Width (mm)	48.37±4.77	44.25±4.41	.042*
Left renal parenchymal thickness (mm)	16.05±3.08	15.44±3.28	.569

Table VI. Age wise distribution of the study subjects (N = 55)

Characteristics (mean±SD)/(number)	<50 years N = 36	>50 years N = 19	P value
RK length (mm)	102.69±8.83	98.89±8.28	.712
RK width (mm)	43.89±6.511	41.05±7.10	.904
Right renal parenchymal thickness (mm)	14.89±3.57	14.64±2.62	.560
LK length (mm)	104.19±8.99	103.37±9.19	.808
LK Width (mm)	46.42±5.12	44.26±4.25	.017*
Left renal parenchymal thickness (mm)	16.57±2.48	13.91±.72	.567

Those who have higher BMI, their parenchymal thickness (mm) of right kidney and length (mm) of the left kidney were significantly higher than those who have BMI lower than 25.0 (Table VII).

Table VII. BMI wise distribution of the study subjects (N = 55)

Characteristics (mean±SD)/(number)	BMI<25.0	BMI≥25.0	P value
	N=23	N= 32	
RK length (mm)	102.17±7.177	100.81±9.819	.111
RK width (mm)	43.78±6.967	42.28±6.707	.689
Right renal parenchymal thickness (mm)	14.8696±4.09161	14.7625±2.55782	.013*
LK length (mm)	104.52±6.728	103.47±10.395	.017*
LK Width (mm)	46.52±5.062	45.06±4.785	.927
Left renal parenchymal thickness (mm)	15.0783±3.82432	16.0688±2.65518	.667

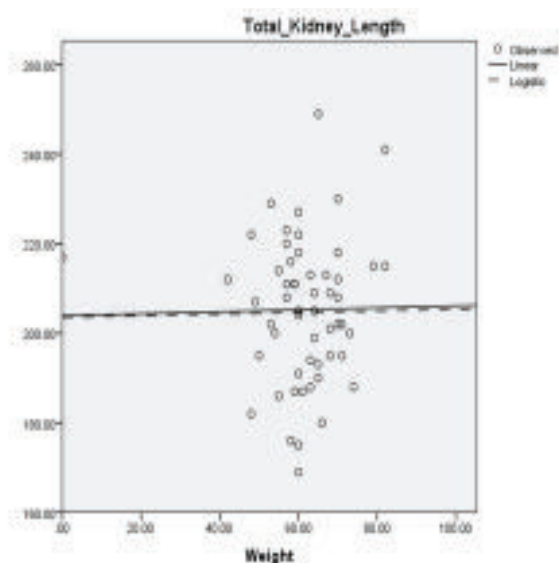
Those who have higher duration of DM (≥10 years) their length and PT of LK were significantly higher than those whose have less duration of DM (<10 years) (Table VIII). Those who had hypertension their length of RK and length of LK were significantly higher than those of normotensive patients (Table IX). Correlation between renal length and weight showed a positive correlation (r = 0.16). (Figur 1).

Table VIII. Comparison of renal size in diabetic subjects according to duration of diabetes mellitus in years (N = 19)

Characteristics (mean±SD)	Duration of DM	Duration of DM	P value
	<10 (N=5)	≥10 (N=14)	
RK length (mm)	97.36±7.40	110.20±5.40	.199
RK width (mm)	44.21±8.12	41.20±7.49	.703
Right renal parenchymal thickness (mm)	16.00±2.51	13.78±2.10	.410
LK length (mm)	102.29±10.75	107.60±3.84	.050*
LK width (mm)	43.86±4.81	43.80±4.97	.943
Left renal parenchymal thickness (mm)	15.75±2.55	12.6400±6.62	.050*

Table IX. Comparison of renal size in between hypertensive and normotensive subjects (N = 55)

Characteristics (mean±SD)	Hypertensive (N=18)	Normotensive (N=37)	P Value
RK length (mm)	101.83±10.91	101.16±7.66	.035*
RK width (mm)	42.06±7.40	43.32±6.54	.959
Right renal parenchymal thickness (mm)	14.14±2.42	15.12±3.57	.477
LK length (mm)	104.08±8.21	103.56±10.65	.025*
LK width (mm)	44.39±5.11	46.30±4.75	.696
Left renal parenchymal thickness (mm)	14.36±4.19	16.28±2.41	.268

Renal length and body weight correlation**Figure 1.** Correlation between renal length and weight showed a positive correlation

DISCUSSION

The normal size of a kidney is variable and is affected by age, gender, ethnicity, pregnancy, BMI, as well as the side. Kidney size also depends upon co-morbid conditions like DM and HTN. Normal renal length varies from 100 to 124 mm.²⁶⁻²⁹ The minimal size of a fully functional kidney is 90 mm in length.³⁰ The size provides a rough indication of the renal function, decrease of size and function are seen with chronic renal failure.³¹

Commonly, USG is used to screen and measure the kidney. Most of the study showed that USG estimated renal length is the most commonly used and most practical measurement in clinical practice and is correlated to renal function.^{32,33} In this study of 55

healthy individual showed mean length of RK was 101.38±8.76 mm and mean length of LK was 103.91±8.98 mm. The kidney length of our population is like population of our sub-continental populations like India³⁴, Pakistan³⁵ and Malaysian.³⁶ In our study length, width and PT of LK were significantly higher than those of RK respectively which is similar to other studies.^{37, 38} This variation of renal length could be related to the hepatic mass on right side which does not allow comparable vertical growth of the right kidney to that which is attained by the left kidney. In our study, kidney length and width were significantly larger in females than in males this is not finding by other investigators.

In this study, age ranged from 27 to 71 years with mean 46±10 years. Age of an individual has an important effect on the kidney size. Study found that the kidney size increases till the 3rd decade, remains stable through the middle age and then declines. In our study we found that younger subjects (i.e. age < 50 years) had bigger kidney in relation to elderly subjects because age related decline kidney mass.³⁹

Mean BMI of the study population were 25.7 ± 4.8 kg/m². In this study, we found that higher BMI subjects had higher PT and length of the kidneys. The renal size increased correspondingly with an increasing BMI and there is strong correlation renal volume with BMI.⁴⁰ In our study, we found that diabetic subjects had large kidneys size. Study showed that in early stage of DM there is increase in renal size^{41,42} which is corresponding to our finding.

Renal size also depends on hypertension. In our study, we found that hypertensive subjects had higher renal size than normotensive subjects. Study showed that in long-standing hypertension, however, the kidney size is shown to decrease due to ischemic changes with

resultant fibrosis and hyalinization.⁴³ In our study, we found that there is positive correlation between renal length and body weight which is similar to other study.⁴⁴

In conclusion, normal values for kidney measurements are dependent on age, sex and BMI. This has to be considered by the ultrasonographer. A slightly small right kidney may be considered as normal. In diabetic subjects, an increase in kidney size with an increased glomerular filtration rate in early stage of DM, which is normal. This pilot study gives an idea about renal dimensions of Bangladeshi population. Further large scale population based study is required for establishment of nomogram for renal size in Bangladeshi healthy adult population.

Author's contribution: SKS and MAR planned the study. SKS, MAR, RNI drafted manuscript. IMB, TMR performed ultrasonography of patients. SHH analyzed data and interpreted results. All authors read and approved final manuscript for publication.

Conflicts of interest: Nothing to declare.

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