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Ultrasonographic Measurement of Renal Length in Chronic Kidney Disease with eGFR Correlation

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ABSTRACT

Introduction: *Chronic kidney disease (CKD) is global health problem causing significant mortality and morbidity. This study was carried out to determine the correlation of ultrasonographically measured renal length with estimated glomerular filtration rate (eGFR) in patients with CKD.* ***Methods:*** *This cross-sectional study was carried out in the department of Radiology and Imaging, Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) during the period of July 2016 to June 2017, enrolling 42 patients having clinical diagnosis of CKD who were not on dialysis and who have at least three serum creatinine reports records within 90 days of the ultrasound. All the patients underwent ultrasound examination to measure the renal length of both kidneys. The renal ultrasound examinations were done by the researcher at first, and then confirmed by a consultant of the Department of Radiology and Imaging. All findings of serum creatinine, eGFR and ultrasonography were collected in a pre-designed data collection sheet.* ***Results:*** *Significant positive correlation was found between mean renal length and Cockcroft-Gault (CG) eGFR of patients with clinical diagnosis of CKD. The values of Pearson's correlation coefficient was 0.340, which is significant ($p<0.05$).* ***Conclusion:*** *This current study concluded that renal length had weak positive correlation with eGFR. Renal length measured at ultrasound appears to be related to the degree of renal impairment in patients with CKD, who are not on dialysis and routine measurement reporting of renal length should be considered in such patients.*

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INTRODUCTION

Chronic kidney disease (CKD) is a worldwide public health problem. Kidney damage is defined as pathological abnormalities in blood or urine tests or imaging studies. The incidence and prevalence of kidney failure are rising, the outcomes are poor, and the costs of management are high.[1,2] The incidence, prevalence, mortality and cost for patients with kidney failure treated by dialysis and transplantation, the end stage of CKD, have increased steadily during the past two decades. The major outcomes of CKD, regardless of cause, include progression of kidney failure, complications of decreased kidney function, and cardiovascular disease (CVD). Increasing evidence indicates that some of these adverse outcomes can be prevented or delayed by early detection and treatment.[3] Glomerular filtration rate (GFR) is the best measure of overall kidney function in health and disease. The GFR represents the rate at which an ultrafiltrate of the plasma is formed by the glomeruli. Normal GFR in young adults is approximately 120 to 130 mL/min per 1.73 m^2 and declines with age.[4] A GFR level less than 60 mL/min per 1.73 m^2 represents loss of half or more of the adult level of normal kidney function. Below this level, the prevalence of complications of chronic kidney disease.[5] Renal function is commonly assessed by serum creatinine (S_{cr}), but it has some shortcomings. Both the muscle mass and quantity of ingested meat in addition to the urinary clearance will determine the level of the serum creatinine. Some drugs, including trimethoprim and cimetidine, inhibit creatinine secretion, thereby reducing creatinine clearance and elevating the serum creatinine level without affecting the GFR. S_{cr} may remain within the normal range despite a reduction in GFR of 60% or greater. So the use of S_{cr} alone as a measure of renal function is not reliable.[6] Also blood urea nitrogen (BUN) is a poor marker of GFR as it is heavily influenced by state of hydration, nitrogen load and metabolism.[4,6] Chronic kidney disease is defined as either kidney damage or GFR < 60 ml/min/1.73$m^2$for $\geq$ 3 months.[7]

Ultrasonography is one of the several methods to evaluate renal morphology. Different studies showed that ultrasonography is a rapid and non-invasive diagnostic method for renal disease and also the first method of choice for screening and follow up of patients and healthy people.[7] Traditional technique is that renal length correlates with renal function in CKD, and therefore, bipolar renal lengths are almost always reported at renal ultrasound.[8]

The purpose of this study was to determine whether there is a relationship of renal length measured at ultrasound with estimated glomerular filtration rate (eGFR) as renal function in patients with CKD, using two widely accepted computational methods of estimating GFR. This study was directed towards looking for a simpler method of determination of functional capacity of kidneys in CKD, particularly in resource poor settings. So, this study was supposed to help evaluating the relationship of estimated glomerular filtration rate (eGFR) with renal length in CKD by ultrasonography which is easily available, less costly, radiation free and non-invasive.

METHODS

This cross-sectional study was carried out in the department of Radiology and Imaging, Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) during the period of July 2016 to June 2017. A total of 52 patients having the clinical diagnosis of CKD, who were not on dialysis, at least three serum creatinine reports and weight recorded within 90 days of the ultrasound, were selected for ultrasound scanning. A total of 10 subjects were excluded due to sonographic findings of hydronephrosis and 42 patients were finally enrolled in this study. Prior to the commencement of the study, the research protocol was approved by thesis committee (Local ethical committee). The objectives of the study along with its procedures, risks and benefits of this study were explained to the subjects in easily understandable local language and then informed written consent was taken from each subject. It was assured that all information's and records would be kept confidential and the procedure would be helpful for both physicians and the patient for the evaluation of the functional capacity

of kidneys in CKD, by ultrasonography which is easily available, less costly, radiation free and non-invasive. Patients on dialysis were not included in the study. A detailed history and physical examination with emphasis on the urinary system was recorded. The lowest creatinine performed within 90 days of the ultrasound was used for estimated glomerular filtration rate (eGFR) calculations, as it represents the best recorded renal function during the study period and helps to minimize the influence of superimposed acute on chronic renal insufficiency.[4] The Cockcroft-Gault (CG) and the modification of Diet in Renal Disease Study (MDRD) equations were used for estimated glomerular filtration rate (eGFR) calculation.[1] All the patients underwent ultrasound examination to measure the renal length of both kidneys. The renal ultrasound examinations were done by the researcher at first, and then confirmed by a consultant of the Department of Radiology and Imaging. All findings of serum creatinine, eGFR and ultrasonography were collected in a pre-designed data collection sheet. Statistical analysis of the results was done by computer software devised as the statistical package for the social science (SPSS-20). The results were presented in tables, figures and diagrams. Mean renal length was used in analysis. The relationship between ultrasound measurements and estimated glomerular filtration rate were tested using Pearson's correlation coefficient test and linear regression. Significance was considered at a '*p*' value <0.05.

RESULTS

The age of the patients ranged from 42 to 85 years and the maximum number was found in 7th decade. The mean (±SD) age was 65.3 years with standard deviation ±10.4 years (Table I).

Table I: Age distribution of the study patients (n-42)

Age (in year)	No. of patients	Percentage
≤50	3	7.1
51-60	10	23.8
61-70	18	42.9
71-80	7	16.7
>80	4	9.5

Mean (±SD) weight was 63.1±6.9 kg with range from 55 to 85 kg (Table II).

Table II: Weight distribution of the study patients (n-42)

Weight (in kg)	No. of patients	Percentage
51-60	18	42.9
61-70	19	45.2
>70	05	11.9

The CG eGFR of the study patients were considered and it was found that maximum (25 patients, 59.5%) patients' CG eGFR belonged to 30-59 ml/min. The mean (±SD) CG eGFR was 34.3± 14.0 ml/min with range from 9.0 to 65.1 ml/min (Table III).

Table III: Distribution of the study patients according to the CG eGFR (n-42)

CG eGFR	No. of patients	Percentage
≤50	03	7.1
51-60	10	23.8
61-70	18	42.9
71-80	07	16.7
>80	04	9.5

It was observed that maximum (25 patients, 59.5%) patients had MDRD eGFR within 30-59 ml/min/1.73m^2. The mean (±SD) MDRD eGFR was found 36.3±14.6 ml/min/1.73m^2 with range from 11.0 to 60.9 ml/min/1.73m^2 (Table IV).

Table IV: Distribution of the study patients according to MDRD eGFR (n-42)

CG eGFR	No. of patients	Percentage
<15	02	4.76
15-29	13	30.96
30-59	25	5.52
60-89	02	4.76

The mean renal length on the right side was 9.72±0.91 cm with range from 8.1 to 11.6 cm and the mean renal length on the left side was 10.05±0.97 cm with range from 8.1 to 12.5 cm. The mean renal length was 9.9±0.9 cm with range from 8.1 to 11.9 cm. Mean renal length had significant relation with eGFR (Table V).

Table V: Mean renal length of the study patients (n-42)

Mean renal length in cm	Mean±SD	Range (min-max)
Right side	9.72±0.91	8.1-11.6
Left side	10.05±0.97	8.1-12.5
Both sides	9.88±0.91	8.15-11.85

Table VI: Pearson's correlation coefficient of different parameters of the study patients

Relation	r value	*p* value
Mean renal length vs CG eGFR	0.810	0.028[s]
Mean renal length vs MDRD eGFR	0.317	0.033[s]

s-significant

DISCUSSION

Renal length has traditionally been considered a surrogate marker of renal function, because renal length decreases with decreasing renal function. Renal lengths are universally reported and are usually the only measurements given at renal ultrasound.[8] In this current study, it was observed that the mean (+SD) age was 65.3 years with standard deviation + 10.4 years with range from 42 to 85 years and most (42.9%) of the patients with chronic kidney disease was found in 7th decade. Poggio et al.[9] found the mean +SD age 56+16 years with range from 34 to 76 years which is comparable with the current study. Levey et al.[10] showed that the mean +SD age was 50.6+12.7 years. Moghazi et al.[11] and Rule et al.[12] observed that the mean age was 45 years with range from 15-82 years and 41+11 years with range from 18-72 years respectively. Adibi et al.[13] have showed that the mean+SD age 38.8+7.7 years with range from 20 to 50 years, where the current study was higher with the above mentioned studies. In this present study it was observed that 52.4% and 47.6% were male and female respectively and male female ratio was almost 1, 1:1, which is similar to the study of Beland et al.[14] and Moghazi et al.[11]

In this current series, mean (±SD) weight was 63.1±6.9 kg with range from 55 to 85 kg and maximum (45.2%) patients were 61-70 kg in weight. Rule et al.[12] and Adibi et al.[13] have observed higher mean weight, which was 82±18 kg with range from 47-162 kg and 71.3±12.8kg with range from 36 to 120 kg respectively. Similarly, Poggio et al.[9] showed that the mean weight was 81.0±20.3 kg with range from 57.0 to 109.0 kg, which may be due to their higher body surface area in their study patients.

In this current series, it was observed that the mean (±SD) CG eGFR was 34.3±14.0 ml/min with range from 9.0 to 65.1 ml/min and maximum (59.5%) patients had eGFR within 30-59 ml/min, followed by 31.0% or eGFR of patients within 15-29 ml/min, 4.8% patient's eGFR <15 ml/min or dialysis and 4.8% patient's eGFR within 60-89 ml/min. Similarly, the mean (±SD) MDRD eGFR was found 36.3±14.6 ml/min/1.73m^2 with range from 11.0 to 60.9 ml/min/1.73m^2 and maximum (59.5%) patients had moderately decreased GFR (30-59 ml/min/1.73m^2), followed by 26.2% severely decreased GFR (15-29) ml/min/1.73m^2), 7.1% kidney failure (<15 ml/min/1.73m^2 or dialysis) and 7.1% kidney damage with mild decreased GFR (60-89 ml/min/1.73m^2). Similarly, Beland et al.[14] found the mean eGFR using CG was 34.8 ml/min with range from 10.6-99.4 ml/min and 36 ml/min with range from 8-66 ml/min using MDRD, which is closely resembled with the current study. In another study, Poggio et al.[9] showed that the mean±SD CG GFR was 31±26 ml/min with range from 10-70 ml/min. Similarly, mean±SD MDRD GFR was 37±30 ml/min/1.73m^2 with the range from 12 to 80 ml/min/1.73m^2, which is comparable with the present study. Levey et al.[10] found most (45.9%) patients had moderately decreased GFR (30-59 ml/min) fol-

lowed by 28.6% severely decreased GFR (15-29 ml/min), 13.9% kidney damage with mild decreased GFR (60-89 ml/min), 9.6% kidney failure (<15 or dialysis) and 2.0% kidney damage with normal or increased GFR (>90 ml/min), which is closely resembled with the current study.

In the current study, mean renal length on the right side was 9.72±0.91 cm with range from 8.1 to 11.6 cm, on the left side was 10.05±0.97 cm with range from 8.1 to 12.5 cm and mean renal length (both right and left) was 9.9±0.9 cm with range from 8.15 to 11.9 cm. Beland et al.[14] found that the mean renal length was 10 cm with range from 7.2-12.4 cm. In another study done by Adibi et al.[13] showed the mean length of kidneys was 10.22 cm with 95% CI: 10.11-10.34 cm. The mean length was observed by the author was 10.25 cm with 95% CI: 10.11-10.40 cm and 10.19 with 95% CI: 10.07-10.32 cm for the left and right kidneys, respectively, which was not significant (p> 0.05). Sanusi et al.[15] showed the right renal length ranged between 7.86 to 12.18 cm with a mean±SD of 10.34±1.28 cm and the left kidney length range was 7.0 to 13.0 cm with a mean±SD of 10.33±1.50 cm. The values of renal length of right side and left side obtained in the present study strongly support these investigators. This present study showed that renal length had positive correlation with eGFR. Correlation coefficient of renal length with CG eGFR was r=0.340, (p<0.05) and with MDRD eGFR was r=0.317 (p<0.05), which were correlated with eGFR. So, Ultrasonographycally measured renal length correlates with estimated Glomerular Filtration Rate (eGFR) in patients with chronic kidney disease. In another study, Adibi et al.[16] showed a correlation between GFR and ultrasonographic kidney sizes, especially the kidney length.

CONCLUSION

From the current study, it is concluded that renal length had strong positive correlation with eGFR. Renal length measured at ultrasound appears to relate to the degree of renal impairment in patients with chronic kidney disease, who are not on dialysis, and routine measurement reporting of renal cortical thickness should be considered in such patients.

Conflict of interest: There is no conflict of interest.

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