

Correlation between Estimated Glomerular Filtration Rate (eGFR) and Sonographic Findings in Patients with Chronic Kidney Disease.

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Abstract

Introduction: Ultrasound can also be used as a non-invasive modality for the evaluation and grading of the chronic kidney diseases. This study aims to correlate the various sonographic parameters with the various grades of CKD based on the eGFR.

Methods: The study was a cross sectional study conducted over a period of one year. Study population was adult patients (between 20 to 60 years) with chronic renal disease not undergoing renal replacement therapy. Patients with liver disease and fatty changes in liver in ultrasound and patient with ascites were excluded from the study. Estimated glomerular filtration rate (eGFR) was calculated by using Cockcroft-Gault (CG) equation and CKD classified according to Kidney Disease Improving Global Outcomes (KDIGO) 2004. Ultrasound was performed for all patients and data were entered in a predesigned proforma. Data analysis was done using SPSS 21.0.

Results: A total of 138 patients met the inclusion criteria and were included in the study. The mean renal length in our study was 9.03cm (± 0.83) on right and 9.00cm (± 0.82) on the left side. The mean renal cortical thickness of right kidney was 1.037 ± 0.20 cm and of left kidney was 1.039 ± 0.20 cm. Renal length and renal cortical thickness demonstrated a negative correlation with grade of CKD while renal echogenicity grading demonstrated a positive correlation with CKD grade.

Conclusions: Renal Ultrasound may be used to grade and monitor progress of chronic kidney disease.

Key words: Chronic Kidney Disease, Estimated Glomerular Filtration Rate (eGFR), Renal Length, Renal cortical thickness, Ultrasound

Introduction

Chronic kidney disease is a major health problem worldwide. The burden of this disease is high in any community. It is associated with common risk factors like hypertension and diabetes, which are prevalent in a major group of today's population. It, in fact, is a growing public health problem and End Stage Renal Disease (ESRD) represents a large human and economic burden.¹ Grading of the chronic kidney disease helps in deciding the treatment and in monitoring the progression of the disease. With the progress in the grade of the disease, there is progressive loss of nephrons, interstitial fibrosis, loss of capillaries.² These pathological changes reflect on Ultrasound as reduced length, reduced cortical thickness and increased echogenicity.^{3, 4} CKD is diagnosed and graded based on the laboratory parameters and calculation of estimated glomerular filtration rate (eGFR). However, ultrasound can also be used as a non-invasive modality for the evaluation and grading of the chronic kidney

diseases. The alteration in renal dimensions as measured on Ultrasound not only helps to diagnose and grade CKD but also helps to study its progression.

This study aims to correlate the sonographic parameters (renal length, cortical thickness, renal echogenicity) with the grades of CKD based on the eGFR.

Methods

The study was a hospital based cross sectional observational study carried out in the department of radiology and imaging of a tertiary care teaching hospital for a period of one year from august 2013 to June 2014. Ethical approval was obtained from the institutional review board. Study population was adult patients (between 20 to 60 years) with chronic renal disease not undergoing renal replacement therapy. Patients in extremes of age (less than 20 years and more than 60 years), patients undergoing renal replacement therapy, patients with liver disease and fatty changes in liver in ultrasound and patient with ascites were excluded from the study.

Estimated glomerular filtration rate (eGFR) was calculated by using Cockcroft-Gault (CG) equation⁵:

$$eGFR = (140 - \text{age}) \times \text{Weight (Kg)} / [\text{Serum creatinine (mg/dl)} \times 72] \times$$

* For female patients, the obtained value is multiplied by 0.85 to get eGFR.

Chronic kidney disease (CKD) was defined and classified according to Kidney Disease Improving Global Outcomes (KDIGO) 2004⁶.

All Ultrasound examinations were performed using Samsung Medison Ugeo H60 Ultrasound machine with 3.5MHz curvilinear probe by a single observer. Renal length was measured as the greatest distance between the upper and lower pole in the sagittal plane. Renal cortical thickness was measured in the sagittal plane over a medullary pyramid, perpendicular to the capsule. It was measured at four regions—the upper pole, the lower pole and two points at the interpolar cortex and the mean was calculated. Renal echogenicity was compared with the echogenicity of the liver and graded according to the Hricak standardized method⁷.

Data was entered in SPSS spread sheet and statistical analysis was done using IBM, SPSS 20.0. Pearson's correlation coefficient was used to correlate various ultrasound findings with grade of CKD. Difference in mean of ultrasound parameters between various CKD grades was analyzed using one-way ANOVA.

Results

A total of 138 patients met the inclusion criteria and were included in the study. The mean age of the patients was 45.5 ± 8.8 years. The median age was 46 (IQ-21) and more than 70% of the patients were more than 40 years of age. The study population comprised of 87 (63.0%) males and 51 (37.0%) females.

The most common cause of CKD was hypertension accounting for approximately 64.5% of the cases. Diabetes mellitus was the second most common cause (10.1%) and in approximately 10.9% of the patients, the cause was unknown (Figure 1).

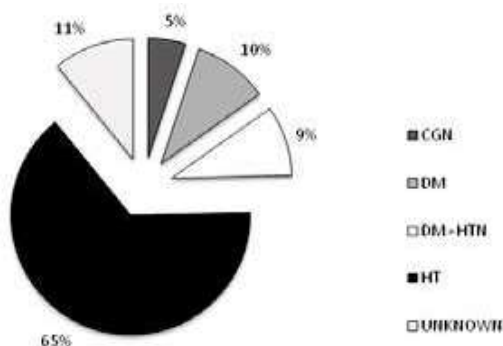


Figure 1. Causes of CKD in the study population

Most patients in our study were in the CKD grade 3 (68; 49.3%) followed by grade 2 (27; 19.6%) and grade 4 (24; 17.4%), (Figure 2).

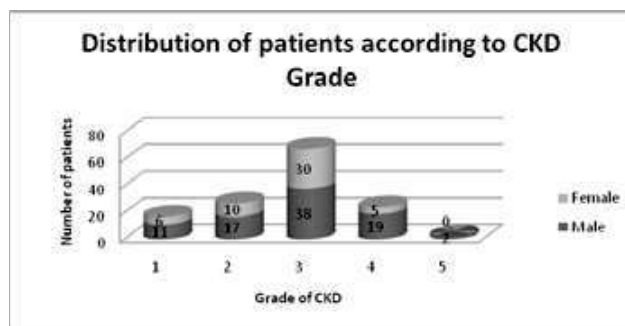


Figure 2. Distribution of patients according to the CKD grade

The mean renal length in our study was 9.03cm (± 0.83) on right and 9.00cm (± 0.82) on the left side. The mean renal cortical thickness of right kidney was 1.037 ± 0.20 cm and of left kidney was 1.039 ± 0.20 cm. Among the studied population majority of the patients had grade 2 echogenicity 65 (47.1%) (Table 1).

Table 1. Table showing mean renal length, mean renal cortical thickness and renal echogenicity distribution among studied population

Ultrasound Parameters	N=138	
1. Renal Length		
Rt Mean ($\pm$ sd)	9.03cm (± 0.83)	
Lt Mean ($\pm$ sd)	9.00cm (± 0.82)	
2. Renal Cortical Thickness		
Rt Mean ($\pm$ sd)	1.037cm (± 0.20)	
Lt Mean ($\pm$ Sd)	1.039Cm (± 0.20)	
3. Renal Echogenicity	Number of Patients	Percentage
Grade 0	7	5.1%
Grade 1	41	29.1%
Grade 2	65	47.1%
Grade 3	25	18.1%

The age and sex of the patients did not show significant variation according to grades of CKD (Table 2).

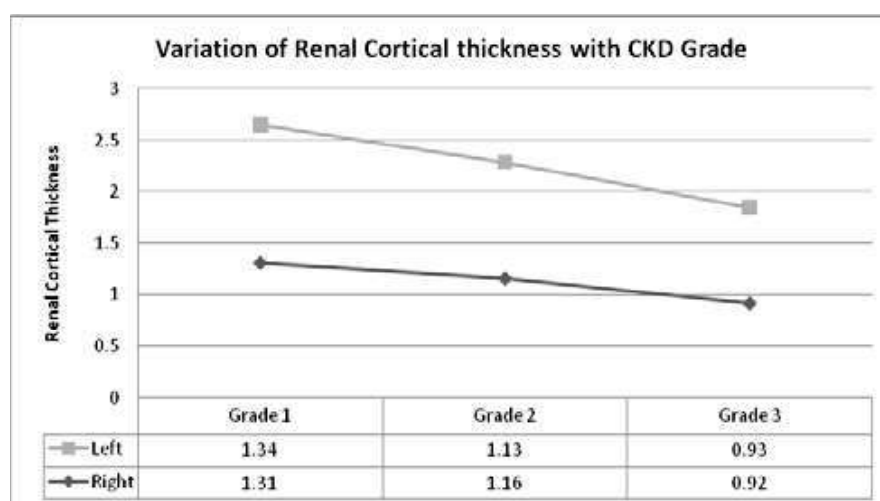
Table 2. Variation of Population characteristics according to grade of CKD

CKD grade No. of cases	Grade ¹ (17)	Grade ² (27)	Grade ³ (68)	Grade ⁴ (24)	Grade ⁵ (2)	Signifi- cance
Age						
Mean (SD)	46.5(8.0)	45.2(8.2)	44.6(9.7)	48.1(6.6)	42.0(19.8)	0.50
Sex						
Male (%)	11 (35.3)	17(63.0)	38(55.9)	19 (79.2)	2(100)	0.25
Female (%)	6(64.7)	10(37.0)	30(44.1)	5(20.8)	0	
Variation of causes with grades of CKD						
Cause	Grade 1 N (%)	Grade 2 N (%)	Grade 3 N (%)	Grade 4 N (%)	Grade 5 N (%)	
CGN	2(11.8)	3(11.1)	0	2(8.3)	0	
DM	4(23.5)	3(11.1)	1(1.5)	6(25.0)	0	
DM+HTN	1(5.9)	0	12(17.6)	0	0	
HTN	9(52.9)	20(74.1)	45(66.2)	13(54.2)	2 (100)	
UNKNOWN	1(5.9)	1(3.7)	10(14.7)	3(12.5)	0	

HTN- Hypertension, DM – Diabetes, CGN- Chronic Glomerulonephritis

Renal length of both right and left kidney demonstrated a negative correlation with grade of CKD with $r=0.51$; $P<0.01$ for right kidney and $r=0.50$; $P<0.01$ for left kidney.

Renal cortical thickness was found to decrease progressively with the increase in the grade of CKD. There was a significant negative correlation between the grade of CKD and renal cortical thickness with the r value of -0.76 ; $p<0.01$ for right and 0.75 ; $p<0.01$ for left kidney (Figure 3).

**Figure 3: Figure showing the variation of renal cortical thickness according to the grade of CKD**

The variation in renal cortical thickness in grade 4 and grade 5 CKD could not be evaluated because of the loss of cortico-medullary differentiation in these higher grades. There was a positive correlation between the grade of CKD and renal echogenicity with R value of 0.87 ($P<0.001$).

Discussion:

The patients included in the study were from 20 to 60 yrs age group. We omitted the extremes of ages, i.e., below 20 and above 60 yrs of age because renal length as well as the renal cortical thickness was found to decrease with ageing of the patient.^{8,9} Most of the patients in the study

were above 40 years of age probably representing age as a risk factor for CKD, which has also been, established in previous studies.¹⁰ However the mean age in our study is lower than other studies studying CKD patient, which might be due to the upper age limit of 60 years in our study.^{10, 11}

Hypertension was the most common cause of CKD in our study, which has also been the most frequent etiology of CKD in previous studies from Nepal.¹² In a study in Nepal Almost 50 percent of newly diagnosed hypertensive were found to have chronic kidney disease.¹³ Also the prevalence of hypertension was seen to be far higher than diabetes in a community study in Nepal.¹⁰ All these facts point towards reduced awareness of

blood pressure control and lack of routine general health check up practice in Nepal for detecting hypertension early before end organ damage. However Diabetes is the most common cause of CKD in the west, which was seen as the second most common cause but far less than hypertension in our study and similar other studies in Nepal.^{12, 14}

Renal length decreases with decreasing renal function and is usually the only marker of renal function measured routinely at ultrasound. The correlation of renal length with eGFR and grade of CKD has been established in several previous studies.^{3, 15, 16} However previous studies have suggested renal cortical thickness is more closely related to eGFR than renal length.³ There was significant stronger positive correlation of CKD grade with renal cortical thickness in our study than with renal length, thus supporting a closer relationship of renal cortical thickness with eGFR. However renal cortical thickness cannot be measured at higher grades of CKD due to loss of corticomedullary differentiation.

Renal echogenicity was classified by Hricak standardized method⁷ comparing echogenicity of the kidney with that of liver and was found to have significant strong correlation with CKD grade. Another study correlating renal echogenicity with eGFR showed a significant association of eGFR with renal echogenicity grade.¹⁵ However Platt et al¹⁷ found that renal echogenicity comparable to hepatic echogenicity was seen even in the absence of renal parenchymal disease and concluded that renal echogenicity similar to hepatic echogenicity was not a good indicator of disease. The difficulty in echogenicity grading might arise with increased incidence of fatty liver (which was an exclusion criteria in our study), which increases liver echogenicity and is also a possible source of inter observer variability.

Our study had certain limitations. The study group excluded elderly patients. Sample size of the study was less to make adequate comparisons between various CKD grades. Renal parenchymal thickness was not assessed. The GFR (renal function) in our study was an estimate rather than true measurement. We excluded patients undergoing renal replacement therapy, as eGFR in such patient would be a function of adequacy of dialysis rather than true renal function.

Conclusions

There is significant correlation of renal length, renal cortical thickness and renal echogenicity with clinical CKD grading. Renal cortical thickness and renal echogenicity showed stronger correlation than renal length. Renal Ultrasound may be used to grade and monitor progress of chronic kidney disease.

Conflict of interest: None declared

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