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Correlation renal cortical echogenicity with serum creatinine in patients with chronic kidney disease

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Abstract

Background: Sonography is the best screening modality to detect renal insufficiency in patients. Because ultrasonographic observations such as echogenicity, longitudinal length, parenchymal and cortical thickness reflect irreversible changes, when it comes to assessing the development of the disease, ultrasonography is a better imaging tool.

Aims: Our aimed to compare renal echogenicity with serum creatinine levels and to investigate the importance of renal echogenicity in the detection of CKD development and the use of sonographic imaging in CKD classification.

Materials and methods: 80 patients above 30 years of age who had been diagnosed with CKD according to the guidelines of the National Kidney Foundation were included in the study. serum creatinine levels. Renal cortical echogenicity was compared with serum creatinine. A *P* value less than 0.05 was considered statistically significant.

Results: In total 80 patients, 38 patients(48%) had sonological Grade 1 CKD, 29(36%) had Grade 2 CKD, 9(11%) had Grade 3 CKD, and 4(5%) had Grade 4 CKD. The mean serum creatinine was 2.7 mg/dl for Grade 1, 3.7 mg/dl for Grade 2 it is 3.9 mg/dl for Grade 3 and 7.8 mg/dl for Grade 4. There was a statistically significant positive association between serum creatinine and the grading of cortical echogenicity. The statistically significant positive association between mean longitudinal size and renal echogenicity, parenchymal thickness and renal echogenicity, cortical thickness and renal echogenicity was also statistically significant.

Conclusion: In CKD patients, renal cortical echogenicity and its grading compared to longitudinal length, parenchymal thickness, and cortical thickness is the strongest sonographic parameter that correlates with serum creatinine. It can be used as a parameter of renal activity because renal cortical echogenicity has the advantage of being irreversible compared with serum creatinine levels.

Keywords: Sonography, creatinine, chronic kidney disease

Introduction

One of the common causes of renal failure is chronic kidney disease (CKD). It implies a steady weakening of the structure and operation of the kidneys over the span of months, with or without a reduced glomerular filtration rate (GFR). CKD may be detected through pathological anomalies, variations in blood or urine levels of kidney function markers, or imaging investigations^[1]. Due to its non-invasiveness, and because it allows simple visibility and observation of the kidneys, ultrasound is the best imaging modality in CKD. Ultrasonography is the first and, in most cases, the only imaging procedure needed for chronic renal failure work-up.

Irreversible damage is demonstrated by examination of a small kidney with a thin, echogenic cortex or parenchym^[2]. Sonography is the best screening tool for determining renal insufficiency in patients. Since ultrasonographic findings such as echogenicity, longitudinal length, parenchymal, and cortical thickness represent irreversible improvements, ultrasonography is a better modality of imaging.

A variety of measures that involve calculating renal length and volume and renal cortical thickness may be used to assess renal morphology. Via renal duration and cortical thickness, renal function can also be measured, and significant therapeutic decisions can be taken on the basis of this. Serial sonographic tests are also carried out to assess the severity or normality of renal disease^[3]. While renal parenchymal volume is a reasonably reliable calculation in patients with end-stage renal disease, in normal patients, longitudinal renal length measurements are adequate.

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In interstitial fibrosis and glomerulosclerosis echogenicity is improved due to the involvement of collagen, but this has never been accepted. Increased echogenicity can also improve interstitial swelling. Echogenicity can also be measured by the human eye, but it is inaccurate. Renal parenchymal echogenicity can be accurately quantitated and identified within a typical range in a small number of adults. Significant associations have been made between renal duration or cortical echogenicity and glomerular sclerosis or tubular atrophy.

Ultrasound is also a good modality for evaluating renal insufficiency and disease progression. Our aimed to compare renal echogenicity with serum creatinine levels and to investigate the importance of renal echogenicity in the detection of CKD development and the use of sonographic imaging in CKD classification.

Materials and Methods

This prospective analysis conducted for one year, from May 2018 to April 2019. Both patients who were approved for kidney ultrasound whose creatinine was measured on the same day the ultrasound was done were considered. This study involved a total of 80 patients.

Inclusion criteria: New patients presenting for CKD workup, patients reported to have CKD as per operational description, CKD stages 3/4/5 and GFR estimated to be < 60 ml / min as measured in the Renal Disease Diet Modification (MDRD) equation, and patients over 30 years of age both male and female.

Exclusion criteria: known acute kidney damage patients, kidney transplant patients, hemodialysis patients, peritoneal dialysis patients, fatty liver patients, chronic liver disease, and single kidney patients.

Ultrasound of the kidneys and liver was conducted with a 3.5-5 MHz sector curved array transducer using the standard B mode grey scale ultrasound. By implementing low tissue harmonic and speckle reduction imaging to reduce the interobserver bias, the parenchymal echogenicity of both the liver and kidney was tested. In a segment visually determined, the longitudinal length was determined to represent the maximum longitudinal section. As analysed from the longitudinal picture, the width and thickness were measured in a segment perpendicular to the longitudinal axis of the kidney. Holding the ultrasound probe perpendicular to the skin is not important. The level of this transverse segment, however, was located very close to the hilum of the kidney but free of the pelvis at the same time.

Renal cortical echogenicity and cortico-medullary differentiation was evaluated. Renal cortical echogenicity was compared and graded with the echogenicity of the liver and renal medulla with

Grade 0: Normal echogenicity less than that of the liver with maintained cortico-medullary differentiation.

Grade 1: Echogenicity the same as that of the liver with maintained cortico-medullary differentiation.

Grade 2: Echogenicity greater than that of the liver with maintained cortico-medullary differentiation.

Grade 3: Echogenicity greater than that of the liver with poorly maintained cortico-medullary differentiation.

Grade 4: Echogenicity greater than that of the liver with a loss of cortico-medullary differentiation.

The data were entered and stored in a spreadsheet (Excel, Microsoft). Statistical analysis was performed between the ultrasonographic renal parameters and serum creatinine levels with the aid of SPSS statistical software(version 17.0). Analysis was done using one way ANOVA and Pearson’s correlation coefficient.

Results

Out of 80 selected patients, 68 were male and 32 were female.

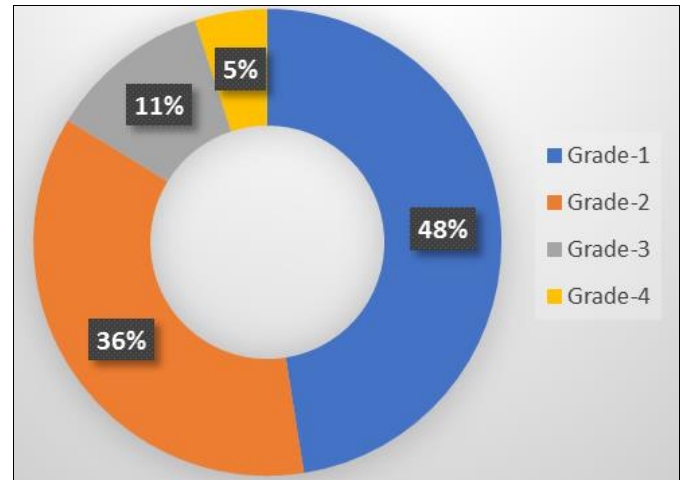


Fig 1: Pie chart displays patients had sonological grading

38 patients(48%) had sonological Grade 1 CKD, 29(36%) had Grade 2 CKD, 9(11%) had Grade 3 CKD, and 4(5%) had Grade 4 CKD.

Table 1: Comparison of serum creatinine with sonological grading

Mean Creatinine in mg/dL				
Renal cortical echogenicity	Number of patients	Mean Value	SD	P-Value
Grade-1	38	2.7	1.8	<0.001
Grade-2	29	3.7	2.1	
Grade-3	9	3.9	1.9	
Grade-4	4	7.8	3.9	
Total	80	4.525	2.425	

The mean serum creatinine was 2.7 mg/dl for Grade 1, 3.7 mg/dl for Grade 2 it is 3.9 mg/dl for Grade 3 and 7.8 mg/dl for Grade 4.

Table 2: Comparison of mean Longitudinal size with sonological grading

Mean longitudinal size(mm)				
Renal cortical echogenicity	Number of patients	Mean Value	SD	P-Value
Grade-1	38	102	12.2	<0.001
Grade-2	29	92	13.9	
Grade-3	9	90	15.2	
Grade-4	4	77	12.3	
Total	80	94.2	14.3	

The mean longitudinal size was 102 mm for Grade 1, 92 mm for Grade 2, 90 mm for Grade 3, and 77 mm for Grade 4.

Table 3: Comparison of mean parenchymal thickness sonological grading

Mean cortical thickness (mm)				
Renal cortical echogenicity	Number of patients	Mean Value	SD	P-Value
Grade-1	38	47.3	6.4	<0.001
Grade-2	29	41.2	7.5	
Grade-3	9	40.3	10.1	
Grade-4	4	37.6	6.6	
Total	80	43.2	8.5	

The mean parenchymal thickness was 47.3 mm for Grade 1, 41.2 mm for Grade 2, 40.3 mm for Grade 3, and 37.6 mm for Grade 4.

Table 4: Comparison of mean cortical thickness sonological grading

Mean cortical thickness (mm)				
Renal cortical echogenicity	Number of patients	Mean Value	SD	P-Value
Grade-1	38	15.4	3.7	<0.001
Grade-2	29	12.4	3.4	
Grade-3	9	11.2	1.6	
Grade-4				
Total	76	13.1	3	

The mean cortical thickness was 15.4 mm for Grade 1, 12.4 mm for Grade 2, and 11.2 mm for Grade 3. Grade 4 involves more echogenicity than the liver, with a loss of corticomedullary definition. Once corticomedullary definition is lost, cortical thickness cannot be measured; hence, includes 76 cases.

Discussion

The CKD has risen exponentially and is exhausting both developed and growing economies' capital and efforts are often needed to reduce the expense of handling this awful disease. The aim of this study was to find a simpler way to determine the functional ability of the kidneys in CKD and to remove (if possible) the need for double GFR determination using serum biochemistry, particularly in resource-poor environments. The ultrasound machine is very inexpensive and widely accessible and provides real-time data on renal measurements and echogenicity, particularly in resource-poor environments [4].

There was a statistically significant positive association between serum creatinine and the grading of cortical echogenicity. The statistically significant positive association between mean longitudinal size and renal echogenicity, parenchymal thickness and renal echogenicity, cortical thickness and renal echogenicity was also statistically significant.

Our analysis found statistically significant positive associations between grade 1 to grade 4 CKD serum creatinine and sonographical grading. A research by Moghazi *et al.* and Siddappa JK *et al.* shows that the greatest association between renal echogenicity and histological parameters was found [4, 5]. Ibinaiye *et al.* had a similar finding [7] Our findings refute those of Platt *et al.*, who find that renal echogenicity is not a reliable disease predictor comparable to the echogenicity of the liver [6]. Normal renal echogenicity is lower than that of the liver in the normal population using speckle reduction imaging (SRI) and low tissue harmonic imaging techniques and indicates a better

echogenicity disparity between the liver and the renal cortex. Rosenfield and Siegel have identified this as well [8]. There was a statistically significant positive association between the rating of renal echogenicity and the mean longitudinal size. Traditionally, renal length has been considered a proxy predictor of renal function because renal length decreases with decreasing renal size [9]. Measuring renal length should be compared to renal volume while repeating renal measurements [10]. A study by Miletić *et al.* reported that relative renal length (calculated using the ratio of kidney length to body height) better represents kidney length because it eliminates sex and height differences [11]. A statistically important positive association between the type of renal echogenicity and cortical thickness was found in our study. our finding contradicted those of Beland *et al.* [12] and Yamashita *et al.* [13] who reported that cortical thickness had statistically significant correlation with renal function impairment.

Consequently, in the case of diabetic nephropathy, it is often difficult to predict the irreversibility of renal failure solely on the basis of renal length or thickness of the parenchyma. Even in the phase of end-stage renal disease, the diabetic kidney can retain the size of a normal kidney [14, 15]. In the present study, ultrasound was able to diagnose the cause of chronic renal impairment due to renal calculi or polycystic kidney disease with certainty in all the 8 cases that were studied. In this context our study supports the findings of Moccia *et al.*, stated that the exclusion of obstructive uropathy or polycystic disease as the cause of renal failure had been always possible with USG. An ultrasound is usually performed in renal failure to exclude the obstructive uropathy [16].

Conclusion

Renal echogenicity and its grading correlate better than other sonographic parameters such as longitudinal scale, parenchymal thickness, and cortical thickness with serum creatinine in CKD. As serum creatinine is a kidney function measure, renal echogenicity is a better criterion for predicting renal function with the additional bonus of irreversibility relative to serum creatinine, which increases in chronic kidney disease with kidney replacement therapy such as hemodialysis, peritoneal dialysis, and renal transplantation.

Compared to serum creatinine levels, which boost with renal replacement therapies such as haemodialysis and peritoneal dialysis, renal cortical echogenicity has the benefits of being irreversible. It can be used as a parameter of renal activity because renal cortical echogenicity has the advantage of being irreversible compared with serum creatinine levels.

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