Section: Radiodiagnosis & Nephrology

Original Research Article

EVALUATION OF ROLE OF ULTRASOUND FOR SONOGRAPHIC GRADING OF RENAL CORTICAL ECHOGENICITY WITH RAISED SERUM CREATININE AND BLOOD UREA LEVELS IN PATIENTS WITH CHRONIC KIDNEY DISEASE

Alvin Wilson[1], Harish Gambhir[1], Kewal Aditya[1], Ankur Wadhera[1], Subhash Singla[1], Jasmine Das[2]

[1]Department of Radiodiagnosis, CMC Ludhiana, India.
[2]Department of Nephrology, CMC Ludhiana, India.

Received : 09/06/2024
Received in revised form : 01/08/2024
Accepted : 16/08/2024

Keywords:
Chronic Kidney Disease, Renal Cortical Echogenicity, Blood urea, Serum Creatinine.

Corresponding Author:
Dr. Kewal Aditya,
Email: kewal_aditya@yahoo.co.in

DOI: 10.47009/jamp.2024.6.4.170

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (4); 866-875

Abstract

Background: Chronic kidney disease (CKD) ranks as one of the most common cause of morbidity and mortality worldwide, making it a major public health concern. In India, there are roughly 800-900 cases of CKD per million people, with an incidence of 180–200 cases per million. Diabetic nephropathy is the most common cause of chronic kidney disease. Ultrasound is a good modality to ascertain renal insufficiency and progression of disease. **Objectives:** To study various renal sonographic changes in patients with chronic kidney disease like renal length, parenchymal thickness, cortical thickness and echogenicity of the kidney and to correlate these parameters with serum creatinine and blood urea levels. Further, to investigate the significance of renal echogenicity in identifying the progression of CKD by sonographic grading of renal cortical echogenicity. **Materials and Methods:** This study was a prospective, cross sectional study conducted in the Department of Radio diagnosis and Nephrology in Christian Medical College and Hospital (CMCH), Ludhiana which commenced from January 2021 to June 2022. Patients were subjected to sonographic examination of kidneys for various renal parameters calculation. These parameters were compared with serum creatinine and blood urea levels. Statistical analysis was done using one-way ANOVA. **Results:** The present study showed a statistically significant correlation between serum creatinine and blood urea with the grade of echogenicity. Significant negative correlation was seen between serum creatinine with renal length/longitudinal size, renal parenchymal thickness, renal cortical thickness. Noteworthy negative correlation was seen between blood urea with renal length, renal parenchymal thickness, renal cortical thickness. **Conclusion:** Renal echogenicity and its grading correlates better with serum creatinine and blood urea in CKD than other sonographic parameters like longitudinal size, parenchymal thickness, and cortical thickness. Hence renal echogenicity is a better parameter to estimate renal function.

INTRODUCTION

Renal failure can have several common causes, one of which is chronic kidney disease (CKD). It entails a gradual decline in kidney structure, function and GFR over several months. Pathological abnormalities, variations in kidney function marker levels in the blood or urine, or imaging tests can all be used to identify CKD.[1] The prevalence of Chronic Kidney Disease (CKD) and the high cost of associated treatment make it a global public health issue. In the world, CKD ranks 12th in terms of mortality and 17th in terms of disability. Given that people with CKD are more likely to die of cardiovascular disease than end-stage renal disease, this figure is subtle (ESRD). In India, it is estimated that there are 800 cases of CKD per million people and 180 to 200 cases of ESRD per million people.[2] CKD is most frequently brought on by diabetic nephropathy.[3] Chronic renal disease is defined as a deranged creatinine level over a few months to years (CKD). The severity of kidney damage is measured by the glomerular filtration rate (GFR), which must be below 60 ml/min per 1.7 m2 for more than three

ISSN (O): 2687-5365; ISSN (P): 2753-6556

months.[4,5] Renal ultrasound can be performed quickly, affordably, and at the patient's bedside to provide the doctor with crucial kidney anatomical information with little inter-observer variability.[6] It is well acknowledged that using ultrasonography for diagnostic purposes is safe.[7] In the clinical setting, ultrasonography is used in the first assessment of patients with chronic kidney disease to rule out possibly manageable causes, decide whether to do a renal biopsy if necessary, and quantify the renal function as a prognostic indicator. In the majority of cases, CKD results in a common final-stage condition marked by small kidneys, cortical and parenchymal thinning (indicating atrophy), and hyperechogenicity (small, dense, echogenic kidneys), which indicates sclerosis and fibrosis. These results point to the disease's irreversibility.[8]

Ultrasonography, is a non-invasive investigative technique that provides enough anatomical features to diagnose kidney illnesses without subjecting the patient to radiation or contrast.[9,10,11] Echogenicity is increased in interstitial fibrosis and glomerulosclerosis. But this has never been recognized.

Normal range of renal parenchymal echogenicity can be reliably quantitated and established in a small set of adults. It was found that there is significant correlation between renal length and cortical echogenicity with glomerular sclerosis or tubular atrophy.[12] Several methods such as measuring renal length, volume, and cortical thickness, can be used to ascertain renal morphology. Renal length and cortical thickness can also be used to assess renal function, and on the basis of this information, crucial clinical decisions can be made. In order to track the development of renal disease or to determine whether it is normal, multiple sonographic examinations are carried out.[13] Measuring renal longitudinal length is adequate in individuals with normal kidney function, despite the fact that renal parenchymal volume is a very precise measurement in patients with end-stage renal illness. Hence, ultrasonography is a useful technique for determining renal insufficiency and disease development. The aim of this study is to evaluate the relationship between renal cortical echogenicity with blood urea and serum creatinine levels, as well as the use of renal echogenicity in detecting chronic kidney disease development by sonographic grading of renal cortical echogenicity.

MATERIALS AND METHODS

This was a prospective, cross sectional study including 70 patients clinically diagnosed with CKD to see the correlation of renal length, parenchymal thickness, cortical thickness and echogenicity of the kidney with serum creatinine and blood urea levels.

Inclusion Criteria

Patients clinically diagnosed with chronic kidney disease (GFR <60/mL/min calculated by using Cockcroft-Gault equation [CCr={(l40–age) x weight)/(72xSCr)} (if male), CCr={(l40–age) x weight)/(72xSCr)}x 0.85 (if female), where CCr (creatinine clearance) is measured in mL/minute, Age in years, Weight in kg, and SCr (serum creatinine) in mg/dL], for three months or more above the age of 18 years presenting to Christian Medical College and Hospital(CMCH),Ludhiana in the departments of Radio diagnosis and Department of Nephrology, during the one and half year study period, commencing from January 2021.

Exclusion Criteria

1. Hemodialysis, peritoneal dialysis
2. Renal transplant patients
3. Patients with hepatic diseases diagnosed on ultrasonography like patients with fatty liver, chronic liver disease
4. Renal tumours
5. Solitary kidney
6. Children less than eighteen years old

Seventy patients, clinically diagnosed with chronic kidney disease (GFR <60/mL/min calculated by using Cockcroft-Gault equation) were enrolled. The patient were made to lie supine on the examination table. The ultrasound coupling gel was applied to the abdomen so as to remove air between the abdominal skin and the transducer. Patients were subjected to sonographic examination with PHILIPS HD 11XE color Doppler ultrasound scanner with a curvilinear transducer, having a variable frequency of 3.5 MHz - 5 MHz. Patients were asked for a thorough medical history, including information on their age, the duration of any existing diabetes or hypertension, any additional causes of chronic renal failure, and previous treatments. The most recent blood urea and serum creatinine levels were recorded. Every patient underwent abdominal ultrasound for the kidneys and liver after giving their informed consent for the investigation. The liver and kidney echogenicities were evaluated with tissue harmonic imaging. The Gain and Time Gain Compensation (TGC) were adjusted manually. The largest pole-to-pole distance in the sagittal plane was used to measure renal lengths (Figure1). Renal parenchymal thickness measured from the renal hilum to the maximum convex border of the lateral renal margin (Figure 2). Renal cortical thickness measured over a medullary pyramid, perpendicular to the capsule as the shortest distance from the base of the medullary pyramid to renal capsule(Figure3). Each time, the average values of the parenchymal thickness, cortical thickness, and right and left renal longitudinal size were computed. Cortico-medullary differentiation and renal cortical echogenicity were assessed (Figure 4).

Renal cortical echogenicity was compared and graded with the echogenicity of the liver and renal medulla as:

Grade 0: Normal echogenicity less than that of the liver with maintained cortico-medullary differentiation (Figure 5). Grade 1: Echogenicity the same as that of the liver with maintained cortico-

ISSN (O): 2687-5365; ISSN (P): 2753-6556

medullary differentiation (Figure 6). Grade 2: Echogenicity greater than that of the liver with maintained cortico-medullary differentiation (Figure 7). Grade 3: Echogenicity greater than that of the liver with poorly maintained cortico-medullary differentiation (Figure 8).

Grade 4: Echogenicity greater than that of the liver with a loss of cortico-medullary differentiation (Figure 9).

Statistical Analysis

The data was entered and stored in a spreadsheet (Excel, Microsoft). Statistical analysis was performed between the ultrasonographic renal parameters with serum creatinine and blood urea levels with the aid of SPSS statistical software (version 25.0). Analysis was done using one-way ANOVA and Pearson's correlation coefficient.

The presentation of the Categorical variables was done in the form of number and percentage (%). On the other hand, the quantitative data were presented as the means ± SD and as median with 25th and 75th percentiles (interquartile range). The following statistical tests were applied for the results:

1. The mean difference among categorical variables was analysed using t-test (for 2 groups) and ANOVA (for more than 2 groups)
2. Pearson correlation coefficient was used for correlation of serum creatinine and blood urea with renal length/longitudinal size(cm), renal parenchymal thickness(cm) and renal cortical thickness(cm).

For statistical significance, p value of less than 0.05 was considered statistically significant.

RESULTS

70 patients clinically diagnosed with chronic kidney disease were included in the study. Various renal sonographic changes like renal length, parenchymal thickness, cortical thickness and renal echogenicity grading were studied.

23 patients (32.86%) belonged to age group 51-60 years while least number 2 patients were in 81-90 year age-group (2.86%). With a Mean value of 54.41 ± 14.7 years with median (25th-75th percentile) of 55 (45-64.75) (Table 1).

48(68.57%) patients were males and 22(31.43%) patients were females (Table 2). Mean value of weight (kg) of study subjects was 69.1 ± 7.72 with median(25th-75th percentile) of 69(63-75) (figure 10). Duration of CKD (years) of 44(62.86%) cases was 1-5 years, 24(34.29%) cases was 6-10 years and 2(2.86%) cases was 11-12 years. Mean value of duration of CKD (years) of study subjects was 4.94 ± 2.63 with median (25th-75th percentile) of 5(3-6.75). Mean value of serum creatinine (mg/dL), blood urea (mg/dL) and creatinine clearance/GFR(mL/mt) of study subjects was 3.25 ± 2.48, 83.86 ± 55.75 and 35.93 ± 18.68 with median(25th-75th percentile) of 2.25(1.34-4.2), 66.5(45-102.075) and 35(20-56) respectively.

Renal length/longitudinal size (cm) of 62(88.57%) cases was normal{8-12 cm}, 7(10.00%) cases was <8 cm{Small} and 1(1.43%) cases was enlarged{>12 cm}. Mean value of renal length/longitudinal size (cm) of study subjects was 9.69 ± 1.14 with median (25th-75th percentile) of 9.7(8.7-10.488).

Renal parenchymal thickness (cm) of 39 (55.71%) cases was reduced {<1.5mm}, 22(31.43%) cases was normal{>=1.5mm} and in 9(12.86%) cases could not assess. Mean value of renal parenchymal thickness (cm) of study subjects was 1.22 ± 0.33 with median (25th-75th percentile) of 1.1(0.95-1.55).

Renal cortical thickness (cm) was reduced in 57 cases (81.43%) whereas could not assess in 13 cases (18.57%). Mean value of renal cortical thickness (cm) of study subjects was 0.98 ± 0.29 with median (25th-75th percentile) of 1(0.8-1.25). Renal cortical echogenicity of 64(91.43%) cases was more than liver, 6 (8.57%) cases was equal to liver.

Cortico-medullary differentiation of 45(64.29%) cases was maintained, 16(22.86%) cases was poorly maintained and loss of CMD was seen in 9(12.86%) cases (Table 3).

Echogenicity grading of 24(34.29%) cases was Grade-I, 20(28.57%) cases was Grade-II, 17(24.29%) cases was Grade-III and 9(12.86%) cases was Grade-IV (Table 4).

Mean ± SD of serum creatinine(mg/dL) in Grade-IV (6.74 ± 2.88) was highest followed by Grade-III(4.8 ± 2.21), Grade-II(2.36 ± 1.08) and mean ± SD of serum creatinine(mg/dL) in Grade-I (1.58 ± 1.04) was lowest. (p value <.0001) (Table 5).

Mean ± SD of blood urea (mg/dL) in Grade-IV (158.57 ± 92.89) was highest followed by Grade-III(99.36 ± 34.61), Grade-II(70.96 ± 31.73) and mean ± SD of blood urea(mg/dL) in Grade-I (55.61 ± 36.34) was lowest. (p value <.0001) (Table 6).

Mean ± SD of serum creatinine(mg/dL) in renal length/longitudinal size:- small{<8 cm} was 6.02 ± 2.87 which was significantly higher as compared to normal{8-12 cm} (2.98 ± 2.25) and enlarged{>12 cm} (0.6 ± 0). (p value=0.004) (figure 11).

Mean ± SD of blood urea (mg/dL) in renal length/longitudinal size:- small{<8 cm} was 153.16 ± 98.69 which was significantly higher as compared to normal{8-12 cm} (77.05 ± 43.53) and enlarged{>12 cm} (21 ± 0). (p value=0.0009) (figure 12).

Mean ± SD of serum creatinine(mg/dL) in patients with renal parenchymal thickness not assessed was 6.74 ± 2.88 which was significantly higher as compared to reduced renal parenchymal thickness {<1.5mm} (3.36 ± 2.08) and normal renal parenchymal thickness {>=1.5mm} (1.61 ± 1.09).(p value<.0001) (figure 13).

Mean ± SD of blood urea(mg/dL) in patients with renal parenchymal thickness not assessed was 158.57 ± 92.89 which was significantly higher as compared to reduced renal parenchymal thickness {<1.5mm} (82.6 ± 35.56) and normal renal

ISSN (O): 2687-5365; ISSN (P): 2753-6556

parenchymal thickness {>=1.5mm} (55.53 ± 37.45).(p value<.0001) (figure 14).

Mean ± SD of serum creatinine(mg/dL) in patients with renal cortical thickness not assessed was 5.88 ± 2.74 which was significantly higher as compared to reduced renal cortical thickness (2.64 ± 2).(p value=0.001) (figure 15).

.Mean ± SD of blood urea(mg/dL) in patients with renal cortical thickness not assessed was 140.35 ± 81.22 which was significantly higher as compared to reduced renal cortical thickness (70.98 ± 38.82).(p value=0.01) (figure 16).

Mean ± SD of serum creatinine(mg/dL) in patients with echogenicity = liver was 2.5 ± 1.84 and in patients with echogenicity > liver was 3.32 ± 2.53 with no significant association between them. (p value=0.446) (figure 17). Mean ± SD of blood urea(mg/dL) in patients with echogenicity = liver was 72.83 ± 60.38 and in patients with echogenicity > liver was 84.89 ± 55.7 with no significant association between them. (p value=0.616) (Figure 18). Mean ± SD of serum creatinine(mg/dL) in loss of CMD was 6.74 ± 2.88 which was significantly higher as compared to poorly maintained (4.84 ± 2.27) and maintained (1.98 ± 1.15).(p value<.0001).

Mean ± SD of blood urea(mg/dL) in loss of CMD was 158.57 ± 92.89 which was significantly higher as compared to poorly maintained (99.94 ± 35.65) and maintained (63.2 ± 34.65).(p value<.0001).

Significant negative correlation was seen between serum creatinine(mg/dL) with renal length/longitudinal size(cm), renal parenchymal thickness(cm), renal cortical thickness(cm) with correlation coefficient of -0.62, -0.505, -0.556 respectively. Significant negative correlation was seen between blood urea(mg/dL) with renal length/longitudinal size(cm), renal parenchymal thickness(cm), renal cortical thickness(cm) with correlation coefficient of -0.496, -0.391, -0.442 respectively. (Table 7, figure 19 and 20).

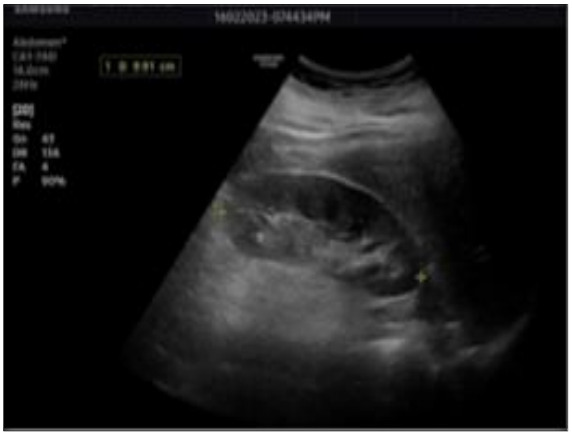

Figure 1: Ultrasound of the Abdomen Showing Longitudinal Section of the Right Kidney with Renal Length Being Measured at the Extreme Pole to Pole Distance

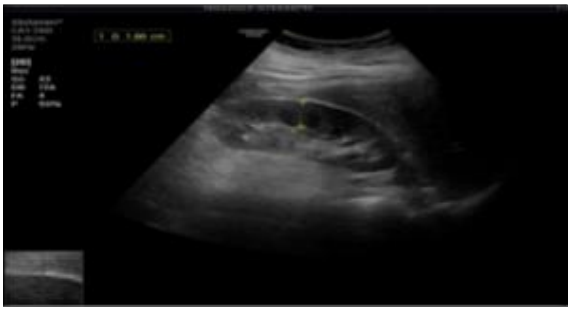

Figure 2: Ultrasound of Abdomen Showing Longitudinal Section of the Right Kidney with the Normal Parenchymal Thickness Being Measured from the Central Sinus Fat up to the Maximum Convex Border

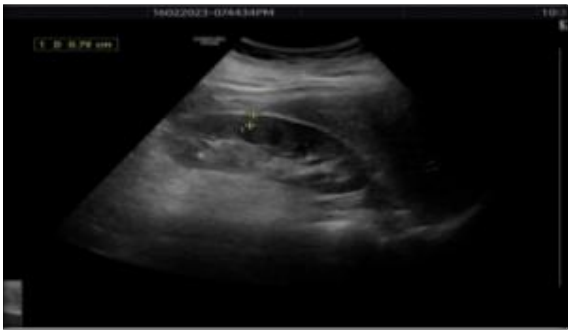

Figure 3: Ultrasound of Abdomen Showing Longitudinal Section of the Right Kidney with Cortical Thickness Being Measured from the Renal Pyramid up to the Renal Capsule

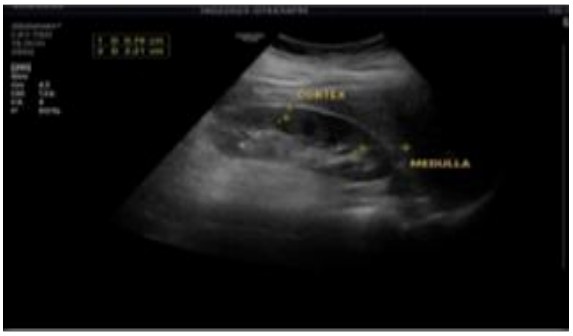

Figure 4: Ultrasound of Abdomen Showing Longitudinal Section of the Left Kidney with intact cortico-medullary differentiation

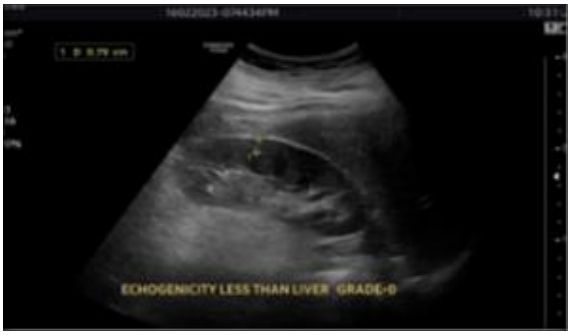

Figure 5: Ultrasound of Abdomen Showing Longitudinal Section of a normal Right Kidney with its Echogenicity Equal less than that of Liver and Maintained Cortico-Medullary Differentiation (Grade-0

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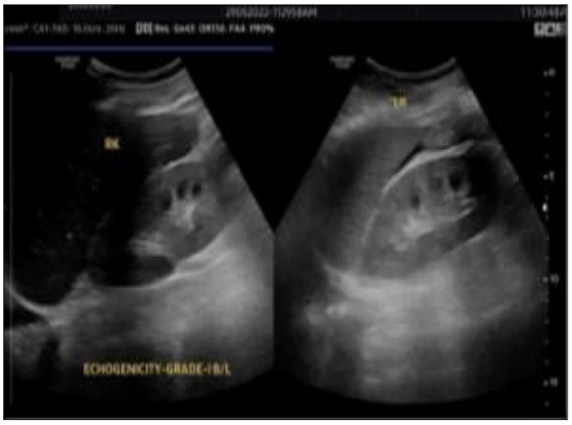

Figure 6: Ultrasound of Abdomen Showing Longitudinal Section of the Right and Left Kidney with its Echogenicity Equal to that of Liver and Maintained Cortico-Medullary Differentiation (Grade-1 Increased Echogenicity)

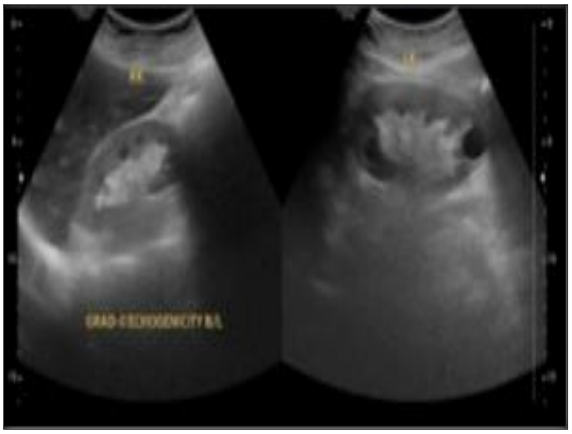

Figure 7: Ultrasound of Abdomen Showing Longitudinal Section of the Right and Left Kidney with its Echogenicity Greater Than that of Liver and Well-Maintained Cortico medullary Differentiation (Grade-2 Increased Echogenicity)

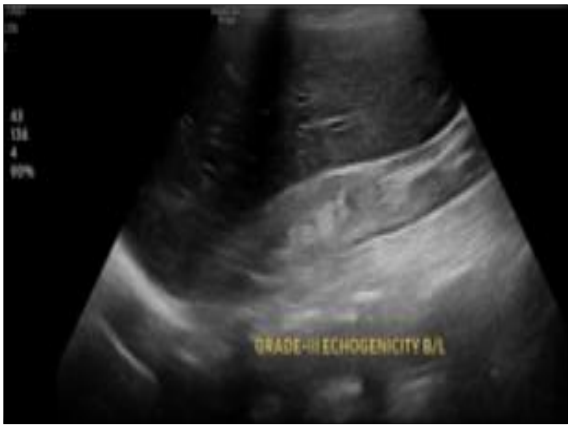

Figure 8: Ultrasound of Abdomen Showing Longitudinal Sections of the Right Kidneys with its Echogenicity Greater Than that of Liver and Poorly Maintained Cortico-Medullary differentiation (Grade 3 Increased Echogenicity)

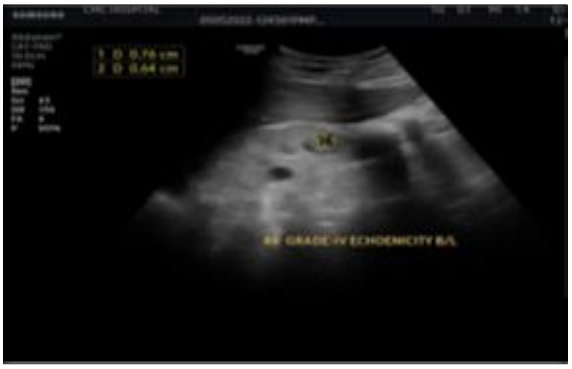

Figure 9: Ultrasound of Abdomen Showing Longitudinal Sections of the Right Kidney with its Echogenicity Greater Than that of Liver and Loss of Cortico-Medullary Differentiation (Grade 4 Increased Echogenicity)

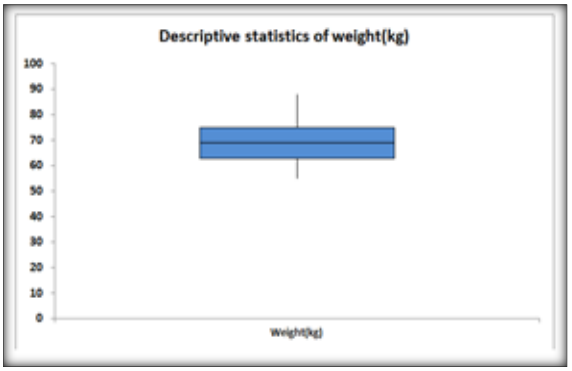

Figure 10: Descriptive statistics of weight (kg)

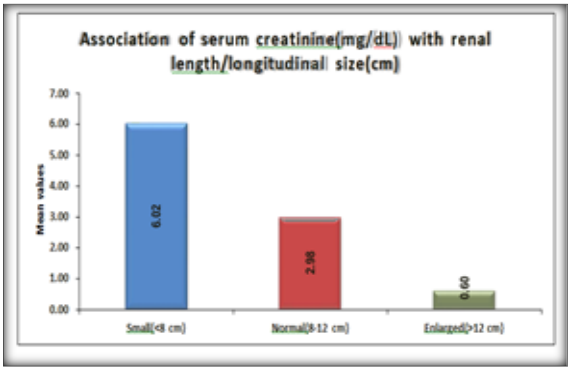

Figure 11. Association of serum creatinine with renal length

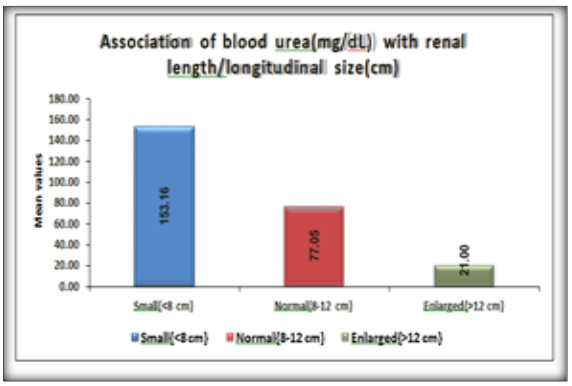

Figure 12: Association of blood urea with renal length

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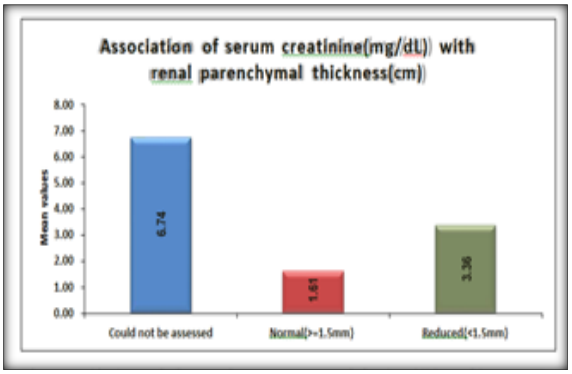

Figure 13: Association of serum creatinine with renal parenchymal thickness

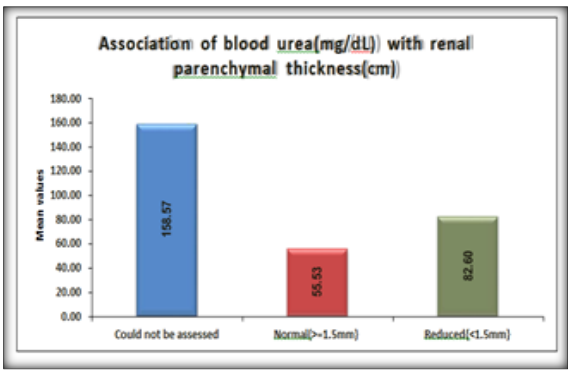

Figure 14: Association of blood urea with renal parenchymal thickness

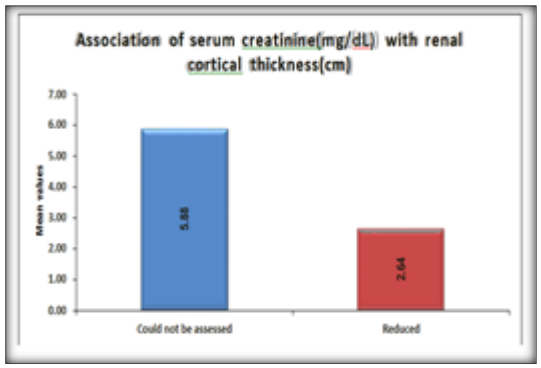

Figure15. Association of serum creatinine with renal cortical thickness

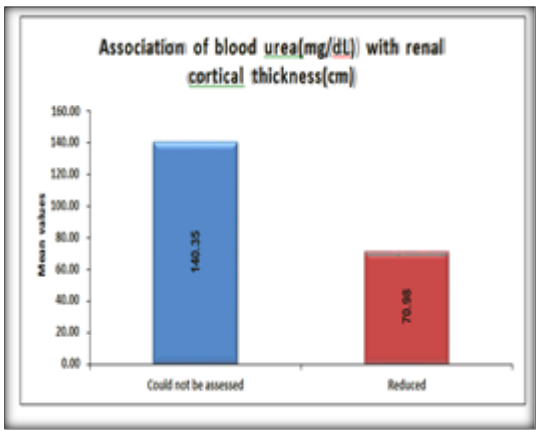

Figure 16: Association of blood urea with renal cortical thickness

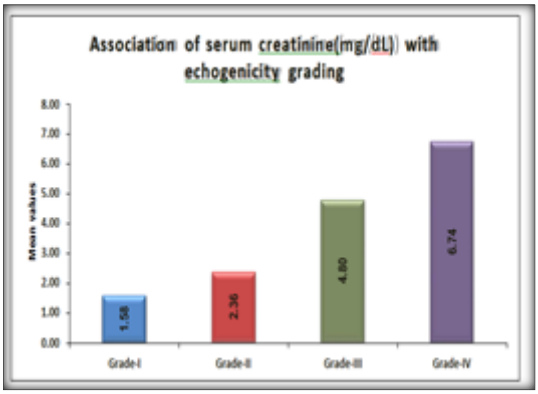

Figure 17: Association of serum creatinine with echogenicity grading

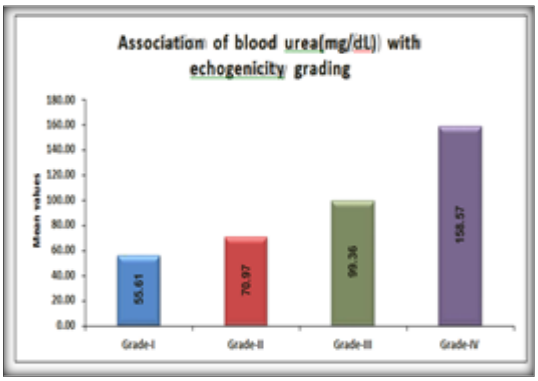

Figure 18: Association of blood urea with echogenicity grading

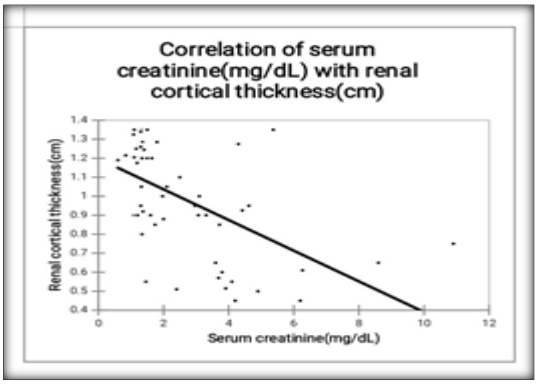

Figure 19: Correlation of serum creatinine(mg/dL) with renal cortical thickness(cm)

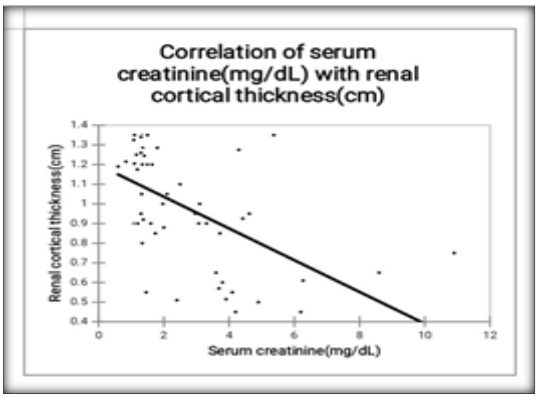

Figure 20: Correlation of blood urea(mg/dL) with renal cortical thickness(cm)

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Table 1: Age distribution

Age(years)	Frequency	Percentage
21-30	5	7.14%
31-40	8	11.43%
41-50	12	17.14%
51-60	23	32.86%
61-70	12	17.14%
71-80	8	11.43%
81-90	2	2.86%
Mean ± SD	54.41 ± 14.7	
Median(25th-75th percentile)	55(45-64.75)	
Range	22-88	

Table 2: Gender distribution

Gender	Frequency	Percentage
Female	22	31.43%
Male	48	68.57%
Total	70	100.00%

Table 3: Cortico-medullary differentiation distribution

Cortico-medullary differentiation	Frequency	Percentage
Loss of CMD	9	12.86%
Poorly maintained	16	22.86%
Maintained	45	64.29%
Total	70	100.00%

Table 4: Echogenicity grading distribution

Echogenicity grading	Frequency	Percentage
Grade-I	24	34.29%
Grade-II	20	28.57%
Grade-III	17	24.29%
Grade-IV	9	12.86%
Total	70	100.00%

Table 5: Association of serum creatinine(mg/dL) with echogenicity grading

Serum creatinine(mg/dL)	Grade-I(n=24	Grade-II(n=20	Grade-III(n=17	Grade-IV(n=9)	Total	P value
Mean ± SD	1.58 ± 1.04	2.36 ± 1.08	4.8 ± 2.21	6.74 ± 2.88	3.25 ± 2.48	<.0001†
Median(25th-75th percentile)	1.33 (1.182-1.425)	2.05 (1.362-3.077)	4.1 (3.72-5)	7.9 (6.23-8.8)	2.25 (1.34-4.2)	
Range	0.6-5.37	1.1-4.62	1.46-10.9	1.2-9.6	0.6-10.9	

Table 6: Association of blood urea(mg/dL) with echogenicity grading

Blood urea(mg/dL)	Grade-I(n=24)	Grade-II(n=20)	Grade-III(n=17)	Grade-IV(n=9)	Total	P value
Mean ± SD	55.61 ± 36.34	70.96 ± 31.73	99.36 ± 34.61	158.57 ± 92.89	83.86 ± 55.75	<.0001†
Median (25th-75th percentile)	45 (31.25-63)	62.5 (48.375-87.325)	101 (84.3-116.8)	141 (90-203)	66.5 (45-102.075)	
Range	14-152	21.7-148	38.8-166	31-331	14-331	

Table 7: Correlation of serum creatinine and blood urea with renal length/longitudinal size (cm), renal parenchymal thickness(cm) and renal cortical thickness(cm)

Variables	Renal length/longitudinal size(cm)	Renal parenchymal thickness(cm)	Renal cortical thickness(cm)
Serum creatinine(mg/dL)			
Correlation coefficient	-0.620	-0.505	-0.556
P value	<0.0001	<0.0001	<0.0001
Blood urea(mg/dL)			
Correlation coefficient	-0.496	-0.391	-0.442
P value	<0.0001	0.002	0.001

Pearson correlation coefficient

ISSN (O): 2687-5365; ISSN (P): 2753-6556

DISCUSSION

The aim of this work was to find a less complicated way to assess the kidneys' functional capability in CKD and, if at all feasible, to do away with the necessity for a second assessment of GFR using serum biochemistry, especially in settings with limited resources. the ultrasound machine offers real-time information on the kidney measures and echogenicity at a relatively low cost and with wide availability. The longest diameter found on a posterior oblique scan was used to measure renal length, with a lower limit of normality often set at 9 cm. Fiorini and Barozzi assert that renal length between 8 and 9 cm should always be associated to the patient's phenotypic, notably the height, and that renal length under 8 cm is unquestionably diminished and should be attributed to chronic renal failure.[14] As a result, 8 cm
was chosen as the present study's lower limit. The useful upper limit of the normal range for kidney length, according to O'Neill, was 12 cm. Moreover, a 2 cm cutoff is thought to be a fair threshold for identifying serious size disparity between the two kidneys.[15]

In the current investigation, 2 kidneys that were longer than 12 cm were deemed oversized.11.43% of the patients had kidney length issues; 10% of the time, the kidneys were small in size, and 1.43 % of the time, they were enlarged. The kidneys were of normal size in the other 88.57% of cases. In the current investigation, the pathological size disparity (>2 cm) was observed in 2% of the instances. One of the two cases with enlarged kidney sizes had unilateral hydrouretronephrosis, and the other had adult polycystic kidney disease, which caused an irregular enlargement of the two kidneys due to numerous cysts. This explains why CKD frequently had nephromegaly, which is why the enlarged kidney sizes in APKD are common.61

According to Moccia et al study, chronic renal illness altered the kidney size in 57% of cases, 7 of which exhibited a size difference.[18] In the current study, the mean renal length was 9.69 cm (range 7.7-12.2 cm; SD= 1.14 cm). This was in line with the findings of Yamashita et al., who found that CKD patients' average renal length was 9.5 cm (range: 6.99–13 cm; SD: 1.25 cm).[16] A normal parenchymal is 1.5 to 2 cm thick. In the current investigation, a mean parenchymal thickness of 1.22 cm (range: 0.8-1.85 cm; SD: 0.33 cm) was found. In 31.43% of the patients, the average parenchymal thickness was normal. It was diminished in 55.71% of the cases, and it was impossible to measure in 12.86% of the cases because the cortico-medullary distinction had been lost. These results were in good agreement with those of Moghazi et al., who discovered that the mean parenchymal thickness was 1.71 cm (Range,0.7- 3.3 cm).[22] The cortical thickness has no recognised normal range. Raj et al. observed an average range of 8 to 11.5 mm in a short sample of transplant donors.[18]

Cortical thickness levels up to 6 mm are also regarded as normal, according to El-Reshaid et al.[19] In our study, the mean cortical thickness was 9.8 mm (range:.4.5 cm–13.5; SD=0.29 cm).13 individuals' cortical thickness could not be measured because USG could not distinguish the renal pyramids. The results showed a slight correlation with those of Yamashita et al, who discovered that the mean cortical thickness in their subjects was 7.1 mm.[20] Beland et al study on CKD patients found a mean cortical thickness of 5.9 mm.[23]

All of the CKD patients in this study reported having elevated renal cortical echogenicity. Only four cases exhibited different echogenicities in the two kidneys, whereas the other 96 cases had similar changes in both kidneys, indicating that echogenicity changes occured bilaterally and symmetrically in CKD patients. According to Paivansalo et al., the most typical anomaly found was an echogenic cortex.[21] In the current investigation, echogenicity was further ranked using the Siddappa et al. categorization.[24]

Grade 1 echogenicity was present in 24 cases (35.29%), Grade 2 in 20 cases (28.57%), Grade 3 in 17 cases (24.29%), and Grade 4 in 9 cases (12.86%). As a result, Grade 1 echogenicity had the most instances. These results were closely linked to those of Siddappa et al, who discovered that Grade 1echogenicity comprised the biggest group, accounting for 48.3% of the cases.[25] Cortico-medullary distinction was also kept in the current study in 64.29% of the instances, maintained inadequately in 22.86% of the cases, and lost in 12.86% of the cases. This result almost agreed with that of Siddappa et al., who found that cortico-medullary distinction was preserved in 83.3% of instances, was only imperfectly maintained in 11.7% of cases, and was lost in 5% of cases.[27] For Grade 1 echogenicity, the mean blood urea and serum creatinine levels in the current study were respectively 1.58 mg/dL and 55.61 mg/dL (with a range of 0.6-5.37 mg/dL; SD=1.04 for-cr. and range of 14-152 mg/dl; SD=36.34 for-B.ur.). Grade 2 echogenicity levels are 2.36 mg/dL and 70.96 mg/dL, respectively (ranges of 1.1-4.62 mg/dL; SD = 1.08 for cr; and 21.7-148 mg/dl;SD = 31.73 for B.ur.). For Grade 3 echogenicity, the respective values are 4.8 mg/dL and 99.36 mg/dl (range: 1.46–10.9 mg/dL; SD: 2.21 for cr.; range:38.8–166; SD: 34.61 mg/dl for B.ur.). According to Grade 4 echogenicity, there are 6.74 mg/dl and 158.57, respectively (with a range of 1.2-9.6 mg/dL;
SD=2.88 for -cr. and a range of 31-331 mg/dL; SD=92.89 for B.ur.). In the current investigation, blood urea and serum creatinine were statistically significantly correlated with the degree of echogenicity (p=0.001). The results of Siddappa et al., who also found a statistically significant association between these two parameters

ISSN (O): 2687-5365; ISSN (P): 2753-6556

(p=0.004), were consistent with this observation.[25] Similar results were found by Ibinaiye et al (r=0.9).

The research findings of Rosenfield and Siegel, who showed that the echogenicity of the kidneys had a good association with the severity of the interstitial disease on biopsy, could be used to explain this correlation. The increase in cortical echogenicity caused by focal interstitial alterations is typically less than that caused by diffuse scarring.[22] The assertion made by Moghazi et al. that renal echogenicity had the strongest connection with histological characteristics, corroborated this finding (Glomerular Sclerosis, Tubular Atrophy, Interstitial Fibrosis and Interstitial Inflammation)(20). Cortical echogenicity and the degree of glomerular sclerosis, focal tubular atrophy, the quantity of hyaline casts per glomerulus, and focal leucocytic infiltration were all shown by Hricak et al to be positively correlated statistically.[26]

Renal length has historically been used as a proxy indicator of renal function; however, in the current investigation, there was no statistically significant association between renal length and blood urea (p=0.0009) or serum creatinine (p=0.004) values. Our findings in this regard were in line with those of Moccia et al., who also found no evidence of a link between renal length and serum creatinine levels.[18] In Van Den Noortgate et al study, which revealed that renal length has a low specificity in predicting renal impairment, provides additional support for this conclusion. The best indicators of renal impairment in clinical settings are serum creatinine, blood urea, and estimated creatinine clearance. They also mentioned that a normal renal length in the elderly, however, can help exclude renal impairment. This conclusion was refuted by our investigation because we did identify older patients with normal renal lengths who also had decreased renal function.

In the current investigation, there was no statistically significant association between parenchymal thickness and blood urea (p0.0001) or serum creatinine (p0.0001) values. This result was in line with that of Yamashita et al., who discovered a non-significant association between parenchymal thickness and renal function deterioration. The measurement of renal parenchyma thickness, which is still often employed in clinical practise to infer various chronic nephropathies, was also advised to be discouraged because it had no statistical relationship with renal function degradation and was therefore worthless in this situation.[19] This result was further supported by the current study. In the current investigation, there was no statistically significant link between cortical thickness and either blood urea (p=0.01) or serum creatinine concentrations (p=0.001). Our results were in line with those of Siddappa etal. in this regard, who found no statistically significant relationship between cortical thickness and serum creatinine levels and reported a p value of 0.656 for these two parameters.[26] Our findings were at odds with those of Yamashita et al,[16] and Beland et al,[24] who claimed that cortical thickness had a statistically significant connection with renal function impairment.[23,19] Moreover, Moghazi et al. demonstrated that there was no connection between cortical thickness and histological variables such glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation.[20]

The present study's statistically negligible relationships between renal measures and serum creatinine and blood urea levels can also be explained by the fact that, in both adults and children, kidney length fluctuates with body height. Also, it has been demonstrated that a person's weight and BMI affect the renal length. While renal hypertrophy in diabetic nephropathy affects all components, unlike ischemic nephropathy, which only affects the cortical layer, the kidney retains its form and architecture in the early stages. The diabetic kidney frequently appears larger and "Better" than the kidney with the same level of chronic, irreversible renal failure brought on by other chronic renal diseases like other glomerular diseases, hypertensive nephropathy, or tubulointerstitial diseases because of the developing nephromegaly.

Because of this, it can be challenging to predict the irreversibility of renal failure in cases of diabetic nephropathy based merely on renal length or parenchyma thickness. The diabetic kidney might maintain its normal size even during the stage of end-stage renal failure. In the current investigation, ultrasonography was able to conclusively identify all of the cases of chronic renal impairment caused by renal calculi or polycystic kidney disease. In this regard, our work confirms the findings of Moccia et al., who found that USG had always been able to rule out obstructive uropathy or polycystic disease as the cause of renal failure. To rule out the obstructive uropathy in renal failure, an ultrasonography is typically used.[18]

This study had some limitations. In the current investigation, blood urea and serum creatinine levels were utilised as indicators of renal function. The best overall indicators of the degree of renal function are estimations of GFR determined by either CG or MDRD equations. We should encourage more research linking these ultrasonographic factors to GFR calculations.

Moreover, because ultrasonography is an operator-dependent modality, repeated assessments of parameters like cortical thickness have demonstrated to have poor repeatability due to inter-observer and intra observer differences.

Notwithstanding its limitations, the current study has shown a significant correlation between renal cortical echogenicity and its grading with blood urea and creatinine levels in the serum. Renal cortical echogenicity has the advantage of being irreversible in contrast to serum creatinine and blood urea levels, which fall with renal replacement therapies like haemodialysis and peritoneal dialysis. Moreover,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

earlier studies have shown that comparing the echogenicity of the renal cortex to that of the liver may be quantified precisely, with little variance between various scanners and probes.

CONCLUSION

Ultrasound measures are crucial in the diagnostic assessment of CKD. Renal length, renal cortical thickness, renal parenchymal thickness, and renal cortical echogenicity, which are US measures, appeared to be significant and independent predictors of the disease. The renal cortical echogenicity was shown to have the strongest correlation. It has the potential to be employed in both the initial diagnosis and the follow-up of CKD patients because US are readily accessible at practically all levels of health care. The renal cortical echogenicity, cortical thickness, and kidney length are specific objective US measures that have a significant potential for independently determining the diagnosis and evaluating the progression of CKD. Other sonographic markers such as longitudinal size (P = 0.085), sparenchymal thickness (P = 0.046), and cortical thickness (P = 0.656) do not correlate as well with serum creatinine and blood urea in CKD as renal echogenicity and its grading do. When compared to serum creatinine and blood urea, which improve with kidney replacement therapy like hemodialysis, peritoneal dialysis, and renal transplantation in chronic kidney disease, renal echogenicity is a better criterion to estimate renal function with the added benefit of irreversibility.

Financial support and sponsorship: Nil
Conflicts of interest: There are no conflicts of interest.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556