Original Article

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Correlation of Sonographic Grading of Renal Cortical Echogenicity with Serum Creatinine in Patients with Chronic Kidney Disease

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Abstract

Background: Ultrasound Imaging can be used as a painless, non-invasive modality for the grading of renal echogenicity in chronic kidney disease (CKD). Aims: To determine the association of renal echogenicity in persons with CKD using ultrasound and serum creatinine Settings and Design: Retrospective observational study design at a single center. **Subjects and Methods:** The study included 112 subjects aged 18 to 90 years with CKD, with grades of renal echogenicity and renal length estimates based on ultrasound findings and biochemical test results of serum creatinine profile. Renal size was categorized as optimal or small or enlarged and renal echogenicity graded from 1 to 4. Statistical Analysis used: A one way Analysis of Variation test (ANOVA) was used to compare the renal echogenicity and renal length with serum creatinine. Pairwise correlations were estimated and a p value of <0.05 was considered as statistically significant. **Results:** The study included 112 subjects with a mean age (SD) of 54.37 (17.29 years) and 81 (72.32%) subjects were males. The majority of patients (n=51, 45.54%) in the study were aged 60 years or older. Sixty eight subjects (60.71%, 95% CI: 51.45, 69.43) subjects had optimal sized kidneys and 8 (7.14%, 95% CI: 3.66, 13.46) subjects had significant discrepancy in renal size. The majority of subjects (n=43, 38.74%, 95%CI: 29.73, 47.64) in the study had Grade 1 renal echogenicity. Serum creatinine values increased significantly with increasing grades of renal echogenicity (F=9.58, p<0.001, one way ANOVA test). The grade of echogenicity and serum creatinine levels showed a statistically significant correlation (p<0.001) on pairwise correlation test. The mean longitudinal renal length was significantly associated (F=14.07, p<0.001) with renal echogenicity. **Conclusion:** Serum Creatinine levels and renal echogenicity were significantly associated in this study. Ultrasound imaging studies can be a painless non-invasive alternate in the evaluation of CKD.

Keywords: Ultrasound, chronic kidney disease, renal length, renal echogenicity, serum creatinine.

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Introduction

Chronic Kidney Disease (CKD), a common cause of renal failure is characterized by progressive loss of the structural and functional integrity of the kidney, with or without decreased glomerular filtration rate (GFR).[1] CKD may be diagnosed by pathological, biochemical or imaging investigations.[1] Ultrasound provides a non-invasive, painless, easily accessible modality to visualize the kidneys and assess renal sufficiency and progression of renal disease.[2-4] A small kidney with a thin echogenic cortex or parenchyma on imaging studies may indicate irreversible damage.[2-4] Serum Creatinine, a biochemical test, can also be used to estimate GFR and the stage of CKD but is an invasive test.[5] An estimated 800 per million population in India may have CKD and the incidence of end stage renal disease is approximately 150-200 per million population.[6] This study aimed to correlate renal parenchymal echogenicity and renal size with serum creatinine among patients graded for CKD using ultrasound at a teaching hospital in south India.

Subjects and Methods

An observational study design was used to identify medical records of patients diagnosed with CKD at the study institute between January 2018 and July 2018. The study protocol was approved by the institutional ethics committee and informed consent was waived as this as a retrospective study with data retrieval from medical records. Consecutive patients aged 18 years or above, diagnosed with CKD based on the guidelines of the National Kidney Foundation1, were included in the study and patients with kidney replacement therapy, fatty liver and other liver diseases were excluded from the study.

Renal ultrasound exams were performed using PHILIPS EPIC 5G machine and C 5-1 Pure Wave probes. The length of the kidneys were measured pole to pole. Renal Parenchyma thickness was measured from the renal hilum to the maximum convex border of the lateral renal margin. Cortical thickness was measured in the sagittal plane perpendicular to the capsule and over the medullary pyramid. The mean values of the right and left renal

longitudinal size was estimated. Renal cortical echogenicity was compared and graded with the echogenicity of the liver and renal medulla and categorized based on the guidelines developed by Sidappa et al.[7] Grade 0 [Figure 1] was considered a normal echogenicity less than that of the liver with maintained corticomedullary definition. Grade 1 [Figure 2] was considered as echogenicity same as that of the liver and maintained corticomedullary definition. Grade 2 [Figure 3] as echogenicity greater than that of the liver with maintained corticomedullary definitions, Grade 3 [Figure 4] as echogenicity greater than that of the liver and poorly maintained corticomedullary definitions and Grade 4 [Figure 5] as echogenicity greater than that of the liver and loss of corticomedullary definitions.

A renal length <8 cm was considered as a small kidney and renal lengths greater than 12 cm as enlarged.3,4,8, A difference of ≥ 2 cm between kidneys was considered as indicative of significant size discrepancy between the two kidneys.3,4 Details of the serum creatinine estimations done for the patients with CKD were retrieved from the medical records.

Data was initially entered into a MS Excel spreadsheet and exported into a statistical software (STATA Version 10.0, College Station, TX, USA) for statistical analysis. The association of serum creatinine with renal echogenicity was analysed using a one way Analysis of Variance (ANOVA) test and pair wise correlation tests estimating a Pearson correlation coefficient. 95% confidence intervals (CI) were estimated for point estimates and a p value <0.05 was considered as statistically significant.

Results

The study included 112 subjects with a mean age (SD) of 54.37 (17.29 years) and 81 (72.32%) subjects were males. The majority of patients in the study were aged 60 years and above [Table 1]. Sixty eight subjects (60.71%, 95% CI: 51.45, 69.43) subjects had optimal sized kidneys and only 8 (7.14%, 95% CI: 3.66, 13.46) subjects had significant discrepancy in renal size [Table 2]. The majority of subjects (n=43, 38.74%, 95%CI: 29.73, 47.64) in the study had Grade 1 renal echogenicity [Table 2]. The mean serum creatinine values in the study were 5.56 ± 3.78 mg/dl (median 5.55 mg/dl). Serum creatinine values increased significantly [Table 3] with increasing grades of renal echogenicity (F=9.58, p<0.001, one way ANOVA test). The grade of echogenicity and serum creatinine levels showed a statistically significant correlation (p<0.001) on pairwise correlation test. Renal size did not show a significant correlation with serum creatinine (R=0.03, p=0.21) in this study. The mean longitudinal renal length was significantly associated (F=14.07, p<0.001) with renal echogenicity in this study [Table 4].

Table 1: Distribution of patients with CKD in the study by age.

Age	N (%)
<30 years	14 (12.50)
31-40 years	10 (8.93)
41-50 years	14 (12.50)
51-60 years	23 (20.54)
>=60 years	51 (45.54)

Table 2: Ultrasound determined discrepancy in renal size and renal lengths among study patients.

Renal Parameters	N (%)
Renal size difference > 2cm	8 (7.14)
Small size Kidneys (any kidney <8cm)	35 (31.25)
Large size Kidneys (any kidney >12 cm)	9 (8.04)
Grade 1 echogenicity	43 (38.74)
Grade 2 echogenicity	36 (32.43)
Grade 3 echogenicity	29 (26.13)
Grade 4 echogenicity	3 (2.70)

Table 3: Serum Creatinine and Grades of Renal Echogenicity in the study subjects.

Grade of Renal echogenicity	Serum Creatinine Mean ± SD	F, P value
Grade 1	3.86 ± 2.78	F=9.58, p<0.001
Grade 2	5.87 ± 3.12	
Grade 3	6.95 ± 4.22	
Grade 4	12.61 ± 6.04	
Total	5.56 ± 3.78	

Table 4: Mean Longitudinal Renal Length and Grades of Renal Echogenicity in the study subjects

Grade of Renal echogenicity	Mean Longitudinal Renal Length Mean ± SD	F, P value
Grade 1	10.03 ± 1.42	F=14.07, p<0.001
Grade 2	8.65 ± 1.51	
Grade 3	8.61 ± 1.11	
Grade 4	6.08 ± 0.42	
Total	9.11 ± 1.59	

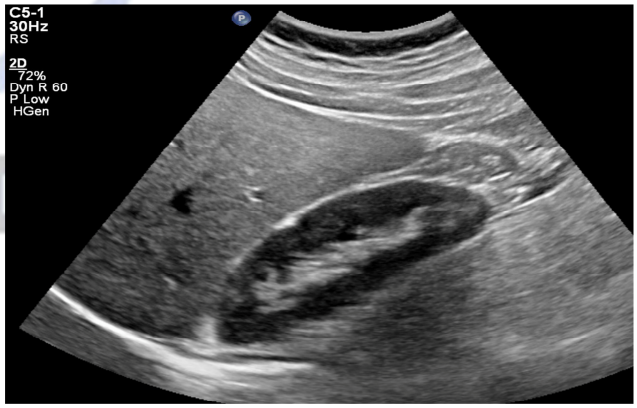

Figure 1: Grade 0 (Normal echogenicity less than that of the liver with maintained CMD)

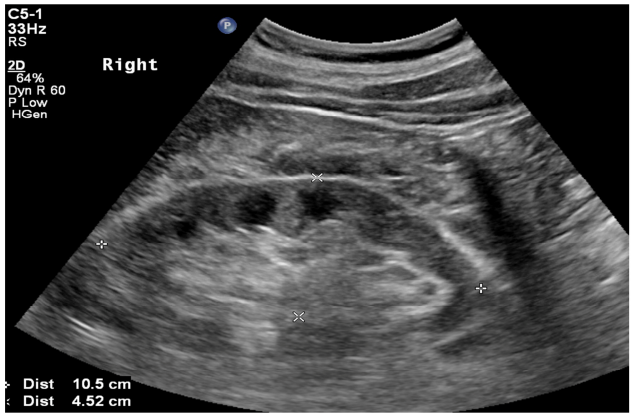

Figure 2: Grade I (Echogenicity same as that of the liver with maintained CMD)

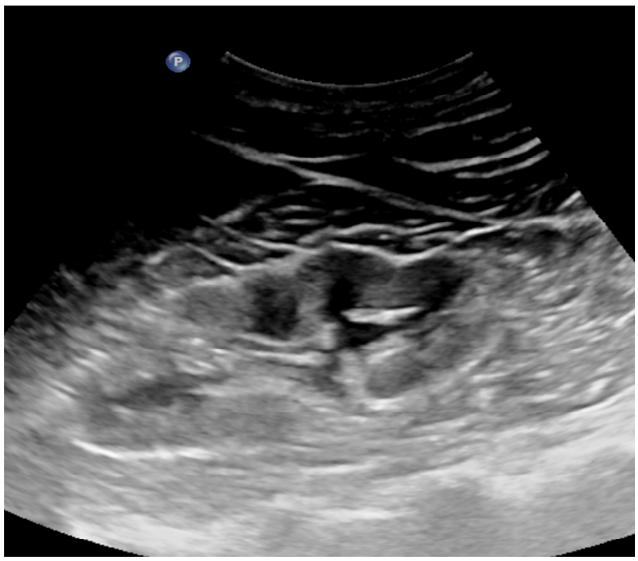

Figure 3: Grade II (Echogenicity greater than that of the liver with maintained CMD)

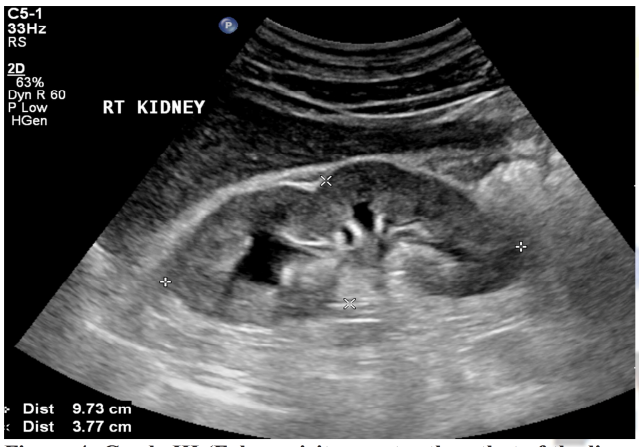

Figure 4: Grade III (Echogenicity greater than that of the liver with poorly maintained CMD)

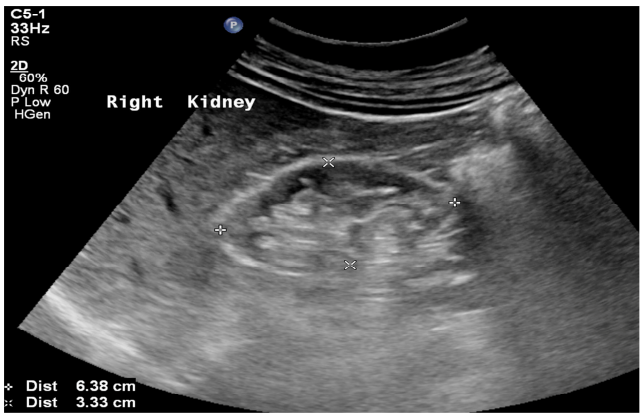

Figure 5: Grade IV (Echogenicity greater than that of the liver with loss of CMD)

Discussion

Previous studies have shown that renal echogenicity has a strong correlation with histopathologic findings.[9-11] A highly echogenic cortex was a common finding and cortical echogenicity was associated with global sclerosis, focal tubular atrophy, focal leukocytic infiltration.[9-11] Our results are similar to these studies. Grade 1 echogenicity was slightly more prevalent in this study and is consistent with the findings reported in a previous study from India.[8]

Nearly 40% (n=44, 39.39%) of subjects in the study had an abnormal renal size and 7.14% subjects had a significant discrepancy in the size of the two kidneys. These findings are consistent with previous studies.[6,12] Renal length is often considered a surrogate marker of renal function. The mean renal length in our study (9.11 ± 1.59 cms) was similar to that reported in previous studies.[6,13]

Serum creatinine levels was significantly associated with renal echogenicity in this study and is consistent with reports from previous studies.[6,8] Serum creatinine levels were not significantly associated with renal length in this study and is consistent with previous studies.[6,8] The association of renal length with serum creatinine levels may be confounded by body height, weight and BMI of adults.[3,14,15] Associated co-morbidity, especially diabetes mellitus, is another potential confounder. Renal hypertrophy in diabetic nephropathy affects all components and the kidney may maintain its structural integrity in the early phases.[6,16] This may make the kidney appear normal or bigger in comparison to kidneys affected by other chronic renal diseases and a diabetic kidney may retain normal size even in end stage renal disease.[6,16]

The study has several limitations. The retrospective nature of data collection limited to a single center is a limitation that can affect generalization of the results and may have influenced the distribution of patients with grades of renal echogenicity. Ultrasound evaluations are operator and skill dependent and it is possible that a subjective bias may have been introduced during the examinations and reporting. However, the present study shows that ultrasound imaging studies and renal echogenicity are useful in CKD and offer an easier, non-invasive, painless alternate to the identification and grading of CKD. Renal cortical echogenicity is usually irreversible, unlike serum creatinine that can reverse with therapy, and may provide a better indicator of the state of the disease. Further prospective studies from multiple centers across India can help toestablish the utility of ultrasound imaging and renal echogenicity in the evaluation of CKD.

Conclusion

Serum Creatinine levels and renal echogenicity were significantly associated in this study. Ultrasound imaging studies can be a painless non-invasive alternate in the evaluation of CKD.

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