Research Article

The Association of Renal Cortical Echogenicity and Length with Serum Creatinine in Patients with Chronic Kidney Disease

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Abstract

Background: The prevalence of chronic kidney disease is 21.2% in Pakistan and rising due to increasing prevalence of diabetes. Ultrasonography is effective tool in early detection and diagnosis of impaired renal function along with renal function tests.

Objective: To study the correlation of serum creatinine with renal echogenicity grading and renal length in patients with chronic kidney disease.

Methods: This prospective cross sectional study was conducted at Medicine, Nephrology and Radiology departments of Pakistan Railway General Hospital, Rawalpindi from 30th September 2021 to 15th July 2022. A total of 200 patients with chronic kidney disease were enrolled randomly by consecutive non probability sampling from medical and nephrology in and out patients after fulfilling inclusion and exclusion criteria per study design. After history, physical examination of serum creatinine was done and the patient was sent for ultrasound in the radiology department. Demographic data and study data was entered on pre designed proforma and analyzed using SPSS21.

Results: Mean age of the patients was 53.45±8.93 years. There were 110 male and 90 female patients in our study. Mean renal length was 9.55 cm. Mean serum creatinine was 1.921 mg/dl with grade 1 cortical echogenicity, 3.561 with grade 2, 4.267 with grade 3 and 6.001 with grade 4 echogenicity respectively on ultrasound. A negative correlation (r= -0.144) was present between renal length and serum creatinine.

Conclusion: Renal cortical echogenicity is a valuable sonographic parameter and is found to be significantly related to serum creatinine level in chronic kidney disease. While renal length showed weaker association with serum creatinine levels.

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Introduction

Chronic kidney disease (CKD) is a major cause of morbidity and mortality worldwide and its prevalence is 13.4%[1] and rising due to epidemic of diabetes, hypertension and obesity. CKD is associated with increased frequency of cardiovascular and stroke events thus increasing health care cost. CKD is defined either as a decrease in estimated GFR below 60ml/min/1.73m^2 or with structural/ functional abnormalities like proteinuria etc for more than three months. Renal replacement therapy in the form of dialysis and transplant is costly

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and inaccessible to poor patients. CKD if recognized early it can be treated but if progresses the reversal of renal function is not possible. Renal function is assessed usually with serum creatinine and GFR is calculated with Cockcroft DW Gault formula.[2] The progression of CKD is monitored by serial GFR.

Ultrasound is used as a first line investigation to assess structural (morphology) and functional (renal perfusion etc) details of kidneys.[3] It gives key information for early detection and progression of CKD. It has been used widely for diagnosis and handheld models are now used commonly by nephrologists in addition to physical examination.[4] As ultrasound is noninvasive, inexpensive and without ionizing radiation, it has been suggested to be incorporated in clinical training and practice to aid in diagnosis.[5]

With B mode ultrasound morphological changes seen in CKD are increase in renal cortical echogenicity, decrease in renal length and cortical thickness, irregular renal margins, calcification in papilla and cyst.[6] Some of these findings correlate better than other in assessing progression of CKD.[7] Serial ultrasound will help to follow the disease course

In Pakistan, prevalence of CKD is 21.2%.[8] Diabetes and hypertension are significant underlying causes.[9] There is lack of resources for management of CKD with costly transplant and regular dialysis. Therefore, it is essential that preventive strategies for early detection and slowing progression of disease are developed. Ultrasound evaluation can be used as an effective preventive strategy to help in early diagnosis and to follow the course of disease in developing countries like Pakistan.

Aim of our study is to correlate ultrasound based renal length and cortical echogenicity with serum creatinine level in patients with CKD. Thus ultrasound finding can be utilized to grade CKD and to ascertain the importance of renal echogenicity in identifying progression of disease as well.

Methods

This prospective cross sectional study was carried out at the Medical department of Pakistan Railway General Hospital in collaboration with the radiology department. A total of 200 patients were enrolled from 16th September 2021, to 15th July2022 after taking permission from ethical review committee of Riphah international University Islamabad. The population sample was calculated with WHO sample size calculator 1.1 with 95% confidence level. Anticipated population proportion of patients with CKD was 21.2%.[8] Absolute precision 6% with minimum sample size of 179.

Patients with CKD above 18 years of age from in-patients and OPD, were sent to radiologists for renal ultrasound who were unaware of serum creatinine value/ CKD stage. All cases were viewed by the same radiologist to avoid inter observer variability. The cases were selected by random consecutive non-probability sampling after consent. Patients with acute kidney injury, obstructive nephropathy, chronic liver disease, renal transplant, and patients on hemodialysis were excluded. Patients were included after informed consent, detailed history and examination particularly about diabetes, hypertension was done.

A Min-dray Ultrasound machine with convex/ curvilinear probe with 2-7 MHZ frequency was used. Kidney length using B mode was the greatest distance from one pole to other longitudinally with 10-12 cm is considered normal.[10] We took the mean of right and left kidney length in every patient. Renal cortical echogenicity of the right kidney was graded compared with liver11.

Grade 0: Echogenicity less than liver.

Grade 1: Echogenicity equal to liver.

Grade 2: More echogenic than liver with clear differentiation of cortex and medulla

Grade 3: More echogenic than liver with poor differentiation of cortex and medulla.

Grade 4: Hyper echoic compared to liver with loss of corticomedullary differentiation.

Statistical data was analyzed with SPSS-21. We calculated mean and SD for age, renal length, and grades of echogenicity. Serum creatinine and USG parameters were compared by pearson' correlation coefficient and ANOVA test.

Results

Out of 200 patients 55% were male and 45 % were female. Age range was 21- 85 years with mean of 53.45 ±8.93 SD. Majority of patients had diabetes and hypertension (60%) both while 10% had diabetes alone and

7% were only hypertensive. In 27% no cause of CKD was established.

The kidney length was normal in 58% patients while 33% had bilateral small kidneys. In 4% subjects unilateral kidney was small. Mean renal length was 9.50 ± 3.90. The mean parenchymal thickness was 1.6 cm. Grade 0 echogenicity was seen in 10% while25% had grade 1, 23% grade 2, 26% had grade 3 and 11% in grade 4 changes. Corticomedullary differentiation was lost in 15%. The mean serum creatinine and cortical echogenicity grade is shown in table I. Pearson's correlation coefficient value -0.144 was calculated between renal length and creatinine. Correlation was significant at 0.05 level.

Table 1: *Comparison of serum creatinine with cortical echogenicity on Ultrasound*

Serum creatinine				
Echogenicity grades on ultrasound	**Number of cases**	**Mean**	**SD**	**P value**
Grade 0	20	1.301	0.561	
Grade 1	50	1.921	1.531	
Grade 2	56	3.561	1.130	<0.001
Grade 3	52	4.267	2.211	
Grade 4	22	6.001	1.219	
Total	200	3.4102	1.330	

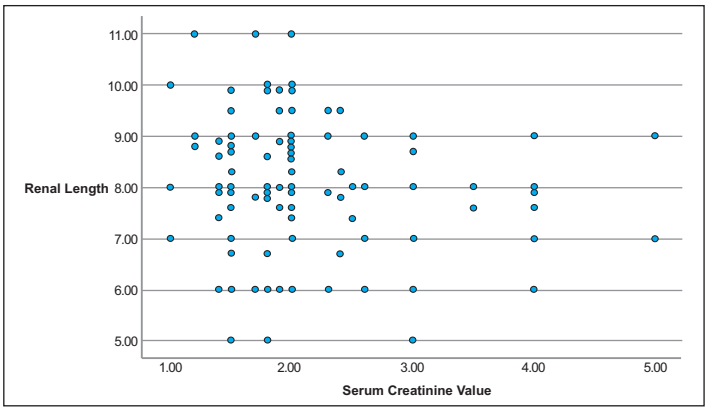

Figure I: *Scatter diagram showing correlation between mean renal length and serum creatinine.*

Discussion

This study showed that serum creatinine correlates with increased cortical echogenicity. With rise in serum creatinine, increase in cortical echogenicity grade was observed. While renal length has weak correlation with renal functions.

Chronic kidney disease is associated with continuing interstitial inflammation, atrophy, fibrosis, glomerular sclerosis and it manifests with increased echogenicity on ultrasound. As the CKD progresses the kidneys become more echogenic, shrink in length, parenchymal and cortical thickness decreases. These changes progress with time.[12] These changes correlate with histological changes seen on biopsy. Nordeval et al. found that a decrease in renal length to body height ratio and cortical thickness are related to histopathological changes in renal parenchyma and severity of renal impairment. When they took cortical echogenicity factor into consideration, correlation became the most strong predictor of renal dysfunction and histologic changes when compared with other parameter.[13,14]

The results of this study showed that serum creatinine level was rising with echogenicity grade. When serum creatinine was up to 2 mg/dl with grade 1 echogenicity and rose up 6-7 mg/dl with grade 4 echogenicity. Similar results were reported by Ahmed et al who reported serum creatinine was 1.85 mg/dl with grade 1 echogenicity and increased to 2.5, 3.27 and 5.03mg/dl for grade 2, 3 and 4 respectively[7]. Similar results were reported from a study conducted in India where strong association was declared with cortical echogenicity grading, renal length and cortical thickness with diagnosis and progression of chronic renal disease.[15] Another study reported similar finding and declared that renal echogenicity is superior to serum creatinine in evaluation of renal function.[16,17]

As CKD is associated with progressive scarring, renal length decreases. When length is below 8 cm, it is a clear indicator of renal dysfunction. Unilateral small kidney may be due to renal artery stenosis or post obstruc-tive nephropathy but bilateral small echogenic kidney clearly defines CKD and correlates with serum creatinine levels.[18] Studies have found strong correlation of renal length with renal impairment. But we differ in our result to show weak correlation between the two parameters similar to results from Kodikara and Jovanovic et al. who declared strong negative relationship between renal length and degree of renal dysfunction.[19,20]

The reason for different results may be because we have more patients with diabetes in our study who had normal size kidneys on ultrasound. While other studies included patients with variable etiologies. Jovana et al. noted

significant difference in renal length after CKD due to primary glomerulonephritis, Blaken endemic nephropathy, diabetic nephropathy, and Adult Poly cystic kidneys (ADPKD). He found reduced renal length in Balken endemic nephropathy and primary glomerulonephritis group compared with diabetic nephropathy group while ADPKD have higher renal length.[21]

In CKD renal length variation with the height, weight, age, sex and BMI of patient has been studied and found variable results.[22] Some found renal length and height ratio is more accurate in this regard.[13] Relative renal length was a better predictor of renal dysfunction than absolute length.[19] While others reported no advantage of relative over absolute renal length.[21]

Renal volume has been considered a more reliable parameter in predicting renal impairment. It requires experience and relies on volume assessment by ellipsoid formula. Some found strong correlation between renal cortical thickness and renal volume measured on CT/MRI with renal dysfunction.[23] While others reported weaker association.[24] Still renal length measurement is an easily reproducible and widely used parameter.

Limitations of the study are that since it was a cross sectional study, follow up scans were not done to observe further decrease in renal length and increase in renal echogenicity. Although patients with all CKD stages were observed. Moreover we have used serum creatinine as marker of renal impairment, assessment of GFR by CG formula is a better indicator of kidney function.[2]

Conclusion

Renal cortical echogenicity is a valuable sonographic parameter and found to be significantly related to serum creatinine level in chronic kidney disease. While renal length showed weaker association with serum creatinine.

Ethical Approval: The Institutional review committee of Islamic International Medical College Rawalpindi approved the study vide letter No. Appl.#Riphah/ IRC/ 21/50.

Conflict of Interest: The authors declare no conflict of interest.

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Authors' Contribution:

SK: Conception and design, data drafting and revising article, final approval of the version

FF: Data analysis and interpretation, drafting and final approval of the version

KF: Conception, design, data analysis and interpretation, revision and final approval

ZJ: Data collection, analysis, interpretation, drafting and final approval

HR: Conception, data collection and analysis and final approval

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