Open Access

Original Article

Correlation of Ultrasonographic Parameters with Serum Creatinine in Patients with Chronic Kidney Disease

Rohaid Khan, Yasir Shakeel, Nisar Ahmed, Atiq Ur Rehman Slehria, Zeeshan Ali, Sara Khan

Department of Radiology, Armed Forces Institute of Radiology & Imaging Rawalpindi/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To determine correlation of ultrasonographic parameters with serum creatinine in patients with chronic kidney disease.

Study Design: Prospective analytical study.

Place and Duration of Study: Armed Forces Institute of Radiology & Imaging Rawalpindi, Pakistan from Apr to Sep 2023.

Methodology: Study included one hundred and sixty patients (n=160), reported to Armed Forces Institute of Radiology & Imaging Rawalpindi, with chronic kidney disease. Patient's data including history and reason for ultrasonography was noted. Convenience sampling was performed after consent. Patient's detailed history including previous comorbid conditions and treatment plan as well as radiological data on ultrasonographic markers like renal length, renal echogenicity, and corticomedullary differentiation and renal functions were also noted. Correlation coefficient analysis, the relation between serum creatinine and ultrasonographic parameters was evaluated.

Results: Out of total one hundred and sixty patients (n=160), 121(76%) were male and 39(24%) were female. Mean serum creatinine for Grade 1, 2, 3 and 4 was 2.92±1.25 mg/dl, 4.00+1.51 mg/dl, 3.90±1.69 mg/dl and for 8.42±3.94 mg/dl respectively. Renal cortical echogenicity and serum creatinine (r=0.499) and mean renal parenchymal thickness (r= -0.157) were shown to be correlated and statistically significant.

Conclusion: There is a stronger correlation between serum creatinine and renal cortical echogenicity and its grading. Therefore, renal cortical echogenicity, which also has the added benefit of irreversibility, is a more accurate radiological indicator for evaluating renal function in kidney disease.

Keywords: Kidney Disease, Renal impairment, Serum Creatinine, Ultrasonography.

How to Cite This Article: *Khan R, Shakeel Y, Ahmed N, Slehria AUR, Ali Z, Khan S. Correlation of Ultrasonographic Parameters with Serum Creatinine in Patients with Chronic Kidney Disease. Pak Armed Forces Med J 2026; 76(4): 468-471. DOI: https://doi.org/10.51253/pafmj.v76i4.11363*

INTRODUCTION

Chronic kidney disease (CKD) is defined as a disturbed creatinine level over a few months to years. The severity of kidney impairment is determined by the glomerular filtration rate (GFR).[1,2] Chronic kidney disease can be identified by pathological abnormalities, variations in kidney function marker levels in the urine, blood, or imaging tests.[3] Ultrasound is the ideal imaging modality in chronic kidney disease (CKD) since it is non-invasive, easily accessible, and makes kidney visualization easy. Ultrasonography is typically the initial and only imaging test required to evaluate chronic renal failure.4 An endogenous serum measure called serum creatinine is frequently used to estimate GFR and, consequently, the stage of chronic kidney disease.[5] The most often used biochemical variable is the serum creatinine level (Scr), while renal ultrasonography features like length, etc are typically employed as diagnostic tools.[6,7] Although ultrasound is well recognized as a noninvasive, economical, secure, and precise imaging technology, there is ongoing discussion on the optimal ultrasound parameter for assessing and monitoring renal function in patients with chronic kidney disease (CKD).[8,9] Every patient had their diagnosis of CKD determined by a doctor using the accepted diagnostic procedures.[10] The conventional method for diagnosing CKD has been to evaluate serum creatinine. When diagnosing chronic kidney disease (CKD), the estimated GFR (eGFR) obtained from equations like the Modification of Diet in Renal Disease (MDRD) equation is more accurate than serum creatinine on its own. No recent study had been conducted regarding correlation between serum creatinine with ultrasonographic parameters in chronic kidney disease The current study aims to ascertain the relationship between serum creatinine and ultrasonographic parameters in patients with chronic kidney diseases. It also explores the role of renal cortical echogenicity in CKD progression

Correspondence: Dr Rohaid Khan, Department of Radiology, Armed Forces Institute of Radiology & Imaging Rawalpindi Pakistan

Received: 01 Jan 2024; revision received: 26 Mar 2024; accepted: 27 Mar 2024

identification and the utility of radio-imaging in CKD grading.

METHODOLOGY

This prospective analytical study was conducted at Armed Forces Institute of Radiology & Imaging (AFIRI) Rawalpindi, Pakistan from Apr to Sep 2023 on one hundred and sixty patients (n=160).

Inclusion Criteria: Patients from both genders aged 18 years or above with chronic kidney disease.

Exclusion Criteria: Patients on kidney replacement therapy (hemodialysis, peritoneal dialysis, and renal transplantation), with advanced cystic kidney disease, hydronephrosis, fatty liver, and other liver illnesses seen on ultrasonography.

The sample size was calculated through WHO calculator using prevalence of chronic kidney disease worldwide as 10% sample size which came out to be 139 and we increase the sample size for generalizability of results, confidence interval 95% margin of error 5%,[11] who were chosen had been given a chronic kidney disease diagnosis in accordance with the National Kidney Foundation's recommendations.[12] Detailed information and history including previous co-morbids and treatment plan as well as radiographs were taken from patients reported to radiology department of AFIRI who went through ultrasound scan. Convenience sampling was performed. Ethical permission was taken from ethical review committee of AFIRI Rawalpindi, Pakistan vide certificate number: AFIRI-RWP-ERB-APRV-28 and granted ethical clearance. In addition, written informed consent was taken from patients and their parents.

Patients' anthropometry, CKD etiology, age, sex, and blood creatinine levels were measured. Two consultant radiologists with 8 and 10 years of experience, respectively, performed ultrasounds of the kidneys and liver using a conventional ultrasound. All patients were examined by both radiologists, who were unaware of the serum creatinine levels of the patients. Radiology databases and patient records were used to gather data on ultrasonographic markers. The grade of the kidney echogenicity was 1. The chosen patients' blood was taken in the collection process. A modified kinetic Jaffe reaction was used to estimate serum creatinine in vitro. Ultrasonographic parameters, serum creatinine was evaluated.

Statistical Package for Social Sciences (SPSS) version 27 was used to analyze the data. The Mean±SD was computed for quantitative data, while frequency and percentage were used for qualitative data. The Shapiro-Wilk test was used to check the normality of data. Correlation coefficient was estimated using Pearson correlation analysis. The p-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of one hundred and sixty patients (n=160) of chronic kidney disease meeting inclusion and exclusion criteria, of which 121(76.0%) were males and 39(24.0%) were females. Out of total 160, 19 (11.8%) had grade 4 CKD, 26 (16.25%) had grade 3 CKD, 44 (27.5%) had grade 2 and 71(44.3%) had grade 1 chronic kidney diseases. The mean of serum creatinine for Grade 1 was 2.92±1.25mg/dl, for Grade 2 it was 4.00+1.51mg/dl, for Grade 3 it was 3.90±1.69mg/dl, and for Grade 4 it was 8.42±3.94mg/dl. The mean longitudinal size for Grade 1 was 103.43+20.66mm, 101.04+16.94mm, 95.46±21.11mm and 77.93±8.17mm for Grades 2 through 4, respectively. For Grade 1, the mean parenchymal thickness was 41.21±10.65mm, Grade 2, 38.52±13.65mm, Grade 3, 43.47±9.71mm and Grade 4, 40.26±9.24mm. For grades one through three, the mean cortical thickness was 21.84±7.52mm, 15.56±6.69mm, 11.70±3.88mm and for grade 4 it was 6.28±5.55mm. The analysis showed statistically significant relation between ultrasonographic features and serum creatinine levels (Table-I).

Table-I: Mean of Ultrasonographic Variables with Serum Creatinine (n=160)

Renal Cortical Echogenicity (Grading)	No. of patients (n)	Mean Serum Creatinine (mg/dl)	Mean Longitudinal Size (mm)	Parenchymal Thickness (mm)	Mean Cortical Thickness (mm)
Grade 1	71	2.92+1.25	103.43+20.66	41.21+10.65	21.84+7.52
Grade 2	44	4.00+1.51	101.04+16.94	38.52+13.65	15.56+6.69
Grade 3	26	3.90+1.69	95.46+21.11	43.47+9.71	11.70+3.88
Grade 4	19	8.42+3.94	77.93±8.17	40.26±9.24	6.28+5.55

The correlation coefficient was estimated for the relationship between grades and the level of the serum creatinine, longitudinal size and mean parenchymal thickness. It was noted that there was positive correlation between grade and level of the creatinine (r=0.499), but the correlation was negative for the mean longitudinal size as the (r=-0.093). Furthermore, there was another parameter estimated which was mean parenchymal thickness and was observed gain a negative correlation with (r=0.157). The correlation was significant for all the parameters for the grades except the longitudinal size. Correlation was also estimate using creatinine values (Table-II).

DISCUSSION

Prospective study includes one hundred and sixty individuals with chronic kidney disease. A

significantly positive correlation was found between serum creatinine and ultrasonographic parameters, $p<0.05$. A study conducted by Saeed *et al*. in Agha Khan Karachi and they found that ultrasonography can be a helpful technique for detecting and monitoring kidney-related disorders. However, were unable to found the correlation between serum creatinine and ultrasonographic parameters.[13] A study by Moghazi *et al*. supports the current investigation, in which renal echogenicity and serum creatinine showed the highest associations.*14* The mean cortical thickness decreased with increasing echogenicity.

Table-II: Relationship Between the Grades of the Renal Cortical Echogenicity, Serum Creatinine and Ultrasonographic Parameters (n=160)

Parameters	Renal Cortical Echogenicity (Grading)	
	Correlation (r)	*p*-value
Serum Creatinine (mg/dl)	0.499	<0.001
Mean longitudinal size (mm)	-0.093	0.240
Mean parenchymal thickness (mm)	-0.157	0.047
	Serum Creatinine (mg/dl)	
	Correlation (r)	p-value
Mean longitudinal size (mm)	0.034	0.666
Mean parenchymal thickness (mm)	-0.110	0.167

A study by Beland *et al*. suggests that cortical thickness, which is evaluated by ultrasonography, is not correlated with renal length. The levels of serum creatinine in their study for Grade 1 was 2.95±1.21mg/dl, for Grade 2 it was 4.15±2.33 mg/dl, for Grade 3 it was 4.23±2.17 mg/dl, and for Grade 4 it was 7.12±3.89 mg/dl.[15] A research conducted by Singh et al. favors our study where the mean serum creatinine values for grade 1 to 4 in mg/dl was 2.87, 3.26, 4.3 mg/dL, and 1.58 mg/dL respectively. These values ranged from 1.8 to 5.6 mg/dL with an SD of 0.81.16 Present study found that mean kidney length was 8.75 cm, the results of present study was in favour of study by Siddappa *et al*. where mean kidney length was found to be 8.69cm.[17]

Furthermore, Prashant Kumar Gupta *et al*. endorse our study. Better sonographic marker renal echogenicity correlates well with eGFR and serum creatinine.[18] The outcomes defy the conclusions of Platt *et al*., who discovered that renal echogenicity—which is synonymous with hepatic echogenicity is not a reliable marker of illness.[19] The most common finding, according to Paivansalo *et al*. and Hricak *et al*., was an echogenic cortex. Global sclerosis severity and cortical echogenicity were found to be positively correlated statistically.[20, 21]

LIMITATIONS OF STUDY

Lack of a control group, observational design, small sample size, exclusion of individuals with normal results, and lack of an association with risk variables were all limitations in the study. Future research can be done with the aforementioned restrictions in mind.

CONCLUSION

Renal cortical echogenicity and its grading correlate more closely with serum creatinine in chronic kidney disease. Therefore, renal cortical echogenicity, which also has the added benefit of irreversibility, is a more accurate indicator than serum creatinine for evaluating renal function in CKD.

Conflict of Interest: None.

Funding Source: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

RK & YS: Conception, study design, drafting the manuscript, approval of the final version to be published.

NA & AURS: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

ZA & SK: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Levey AS, Coresh J. Chronic kidney disease. Lancet 2012; 379(9811): 165-180. https://doi.org/10.1016/S0140-6736(11)60178-5
2. Akbari A, Clase CM, Acott P, Battistella M, Bello A, Feltmate P, et al. Canadian Society of Nephrology commentary on the KDIGO clinical practice guideline for CKD evaluation and management. Ame J Kidney Dis 2015; 65(2): 177-205. https://doi.org/10.1053/j.ajkd.2014.10.013
3. Bailie GR, Uhlig K, Levey AS. Clinical practice guidelines in nephrology: evaluation, classification, and stratification of chronic kidney disease. Pharmacotherapy 2005; 25(4): 491-502. https://doi.org/10.1592/phco.25.4.491.61034
4. O'Neill WC. Sonographic evaluation of renal failure. Am J Kidney Dis 2000; 35(6): 1021-1038. https://doi.org/10.1016/S0272-6386(00)70036-9
5. Tietz NW, Burtis CA, Ashwood ER. Tietz textbook of clinical chemistry. 2nd Edition. Saunders; 1994.
6. Fiorini F, Barozzi L. The role of ultrasonography in the study of medical nephropathy. J Ultrasound 2007; 10(4): 161-167. https://doi.org/10.1016/j.jus.2007.09.001
7. Papatheodorou K, Papanas N, Banach M, Papazoglou D, Edmonds M. Complications of diabetes 2016. J Diabetes Res 2016; 2016: 6989453. https://doi.org/10.1155/2016/6989453
8. O'Neill WC. Renal relevant radiology: use of ultrasound in kidney disease and nephrology procedures. Clin J Am Soc Nephrol 2014; 9(2): 373. https://doi.org/10.2215/CJN.03170313

9. Khati NJ, Hill MC, Kimmel PL. The role of ultrasound in renal insufficiency: the essentials. Ultrasound Quart 2005; 21(4): 227-244. https://doi.org/10.1097/01.wnq.0000186666.61037.f6
10. Levin AS, Bilous RW, Coresh J. Chapter 1: Definition and classification of CKD. Kidney Int Suppl 2013; 3(1): 19-62. https://doi.org/10.1038/kisup.2012.64
11. Kovesdy CP. Epidemiology of chronic kidney disease: an update 2022. Kidney Int Suppl 2022; 12(1): 7-11. https://doi.org/10.1016/j.kisu.2021.11.003
12. Imtiaz S, Alam A. Epidemiology and demography of Chronic Kidney Disease in Pakistan-A review of Pakistani literature. Pakistan J Kidney Dis 2023; 7(1): 2-7. https://doi.org/10.53778/pjkd71209
13. Saeed Z, Mirza W, Sayani R, Sheikh A, Yazdani I, Hussain SA. Sonographic measurement of renal dimensions in adults and its correlates. Int J Collab Res Intern Med Public Health 2012; 4(9): 1626-1641.
14. Moghazi S, Jones E, Schroepple J, Arya K, Mcclellan W, Hennigar RA et al. Correlation of renal histopathology with sonographic findings. Kidney Int 2005; 67(4): 1515-1520. https://doi.org/10.1111/j.1523-1755.2005.00230.x
15. Beland MD, Walle NL, Machan JT, Cronan JJ. Renal cortical thickness measured at ultrasound: is it better than renal length as an indicator of renal function in chronic kidney disease. Am J Roentgenol 2010; 195(2): W146-49. https://doi.org/10.2214/AJR.09.4104
16. Singh A, Gupta K, Chander R, Vira M. Sonographic grading of renal cortical echogenicity and raised serum creatinine in patients with chronic kidney disease. Journal of evolution of medical and dental sciences. 2016; 5(38): 2279-87. https://doi.org/10.14260/JEMDS/2016/530
17. Siddappa JK, Singla S, Al Ameen M, Rakshith SC, Kumar N. Correlation of ultrasonographic parameters with serum creatinine in chronic kidney disease. J Clin Imag Sci 2013; 3: 28.1-6. https://doi.org/10.4103/2156-7514.114809
18. Gupta PK, Kunwar L, Bc B, Gupta A. Correlation of Ultrasonographic Parameters with Serum Creatinine and Estimated Glomerular Filtration Rate in Patients with Echogenic Kidneys. J Nepal Health Res Coun 2020; 18(30: 495-499.
19. Platt JF, Rubin JM, Bowerman RA, Marn CS. The inability to detect kidney disease on the basis of echogenicity. Am J Roentgenol 1988; 151(2): 317-319. https://doi.org/10.2214/ajr.151.2.317
20. Päivänsalo M, Huttunen K, Suramo I. Ultrasonographic findings in renal parenchymal diseases. Scand J Urol Nephrol1985; 19(2): 119-123. https://doi.org/10.3109/00365598509180238
21. Hricak H, Cruz C, Romanski R, Uniewski MH, Levin NW, Madrazo BL, et al. Renal parenchymal disease: sonographic-histologic correlation. Radiology 1982; 144(1): 141-147. https://doi.org/10.1148/radiology.144.1.7089245