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Sonographically Determined Renal Size and Echogenicity as a Predictor of Chronic Irreversible Renal Parenchymal Disease in Glomerulonephritis Patients: Comparison with Histopathology

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Abstract

Background: Renal biopsy remains the gold standard investigation for evaluation of glomerular disease but causes complications in small kidneys and shows chronic changes at histopathology, which are usually non-responsive to treatment. On the other hand, renal sonography is frequently used to judge irreversible renal parenchymal disease, but clinically valuable thresholds have never been established. Specific pathologic changes in renal histopathology that increased cortical echogenicity at sonography have not been defined. Our objective is to correlate renal sonographic parameters with the histopathology of glomerulonephritis and to establish thresholds for renal size and echogenicity that could be useful in making clinical decisions about irreversible renal parenchymal disease in tertiary care hospitals.

Aim of the study: To assess the correlation between sonographic findings and renal histopathology of glomerulonephritis.

Methods: This cross-sectional study was done in the Department of Nephrology of Dhaka Medical College and Hospital (DMCH) over 18 months. As per the inclusion and exclusion criteria, 94 fulfilled the criteria for inclusion. Later, a radiologist did renal sonography, and a biopsy was done. One renal histopathologist evaluated the pathologic findings; 92 patients had completed histopathological diagnosis,1 had only histopathological diagnosis, and one patient's biopsy sample was inadequate. Then, sonographic parameters (length, echogenicity, and cortical thickness) were compared to biopsy findings of glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation, and data analysis was done by SPSS version 22.

Result: Renal cortical echogenicity showed the best correlation with all histopathological parameters, and the r values for glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation were 0.380,0.741,0.761 and 0.320, respectively($p<0.05$). Multivariate analysis showed that only interstitial inflammation (acute and reversible condition) was a significant independent contributor to echogenicity($p<0.05$). Kidney length significantly correlated negatively with glomerular sclerosis, tubular atrophy, and interstitial fibrosis; their r values were -0.638, -0.401, and -0.385, respectively ($p<0.05$). Cortical thickness significantly correlated negatively with glomerular sclerosis, tubular atrophy, and interstitial fibrosis; r values were -0.356, -0.245, and -0.230, respectively ($p<0.05$). Severe chronic kidney disease (>50% sclerosed glomeruli or a score of 3 out of 5 or greater for tubular atrophy or interstitial fibrosis at enal histopathology) was

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present in 62.5% and 8.8% of cases when kidney length <9cm and ≥9cm respectively (p<0.001). When cortical echogenicity ≤ liver and >liver severe disease was present in 2.1% and 44.4% cases, respectively (p<0.001). When kidney length ≥9 cm, echogenicity ≤ liver severe chronic kidney disease was present in 0% of cases (p <0.001). However, together, kidney length <9 cm and echogenicity > liver can predict severe chronic kidney disease in 82.4% of cases (p <0.001) with 77% sensitivity, 95% specificity, a PPV 82%, NPV 94.66% with 92% accuracy.

Conclusion: Cortical echogenicity correlates with histopathology, increasing in acute and chronic conditions. Renal size or echogenicity alone are poor predictors but good predictors of chronic irreversible renal parenchymal disease.

Keywords: Sonographically; Echogenicity; Predictor; Renal Parenchymal Disease; Glomerulonephritis Patients

Introduction

Chronic kidney disease is now a significant public health issue globally. Not only does evidence suggest that hypertension and diabetes are two major causes of chronic kidney disease, but also glomerulonephritis is a leading cause [1]. Kidney disease manifestation does not occur until later and is detected when its structural and functional abnormality becomes chronic. Most causes of chronic kidney disease are irreversible, and treatment is aimed at slow progression. However, chronicity is not always synonymous with irreversibility. Instead, in some cases, chronic kidney disease is entirely reversible, either spontaneously or with treatment [2]. For fulfilling criteria of chronic kidney disease, albuminuria, urinary sediment abnormality, electrolyte abnormality, structural abnormality in imaging and biopsy, or isolated reduced GFR <60ml/min/1.73/m2 are usual markers [2]. B biopsy remains the gold standard for evaluating intrinsic renal disease [3]. The indications for a renal biopsy vary among nephrologists and are in large part determined by the presenting signs and symptoms; the common indications include nephrotic syndrome, nephritic syndrome, unexplained acute renal failure, unexplained chronic kidney disease (CKD), and isolated glomerular hematuria beside assessment of renal involvement in some systemic diseases such as systemic lupus erythematosus (SLE) [4]. In renal biopsy, the glomerulus, the tubules, the interstitium, and the vessels of renal parenchyma are evaluated. Depending on the type of renal disease, one content was changed, or all contents were changed. However, all contents were changed as diseases progressed, so at the end stage, it was not easy to know the origin of all contents [5]. In adult glomerular disease, kidney biopsy is essential for assessing "lesion chronicity," i.e., whether the lesion is reversible or treatable. As glomeruli become scarred, there is consequent atrophy of the remainder of the nephron, and the degree of chronic irreversible damage is generally assessed based on the amount of tubular atrophy/interstitial fibrosis. Because there is a concept of "point of no return," where extensive and irreversible kidney scarring indicates immunosuppressive therapeutic ineffectiveness, it is almost a universal consensus not to perform kidney biopsies in small kidneys [6]. Because renal biopsy in small kidneys with eGFR <30ml/min/1.73m2 may be hazardous and most likely not yield meaningful data [7].

However, the specific threshold for kidney size to perform a renal biopsy is still being determined. Another valuable tool for assessing kidney condition is ultrasonography. Sonography is an essential tool in nephrology for diagnosing and managing kidney disease and guiding invasive procedures [8]. The safety, simplicity, and low cost have made sonography an invaluable tool in nephrology. Moreover, sonography is noninvasive and does not use ionizing radiation. However, it is underused in evaluating renal structural changes to assess chronic renal failure [9]. In addition to visualizing a dilated collecting system, sonography provides information on renal size and the thickness and echogenicity of the cortex. Increased renal parenchymal echogenicity could be used as a predictor of decreased renal function [10]. Cortical echogenicity may increase in acute and chronic renal disease [11]. However, the specific pathologic changes that altered the ultrasonographic parameters have yet to be studied [12]. With this background, the present study aimed to correlate renal sonographic parameters with the histopathology of glomerulonephritis and to establish thresholds for renal size and echogenicity that could be useful in making clinical decisions about irreversible renal parenchymal disease. After searching different journals, we know that such a study still needs to be done in Bangladesh. Due to this paucity of data regarding the subject in our country, this 18-month-long study is intended for patients with renal diseases attending outdoors or admitted into the nephrology department of Dhaka Medical College Hospital.

Methodology & Materials

In this cross-sectional study, 95 patients admitted to the nephrology department were approached for inclusion. After considering the inclusion and exclusion criteria, 94 patients were included in the study. The study was conducted at the Department of Nephrology in Dhaka Medical College Hospital, Dhaka, Bangladesh. The study duration was 18 months, from July 2018 to December 2019. The study's objective was discussed with the patients or their attendants. Written informed consent was obtained from each of the participants. Demographic data, history, and comorbidities of the participants were noted.

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Inclusion criteria:

- Acute kidney injury and chronic kidney disease of uncertain etiology
- Nephrotic syndrome or glomerular proteinuria in adults.
- Nephritic syndrome
- Isolated haematuria or isolated low-grade proteinuria with impaired renal function or Evidence of multisystem disorder
- Willing to participate

Exclusion criteria:

- Patients who had hepatic disease based on clinical and laboratory findings
- Evidence of coagulation disorder
- Pregnant women
- Grossly asymmetric kidney or congenital abnormality

Renal sonographic procedure:

Then, renal sonography was done at the Institute of Nuclear Medicine and Allied Sciences Dhaka Medical campus, where a radiologist obtained all sonographic examinations with a 5 MHz convex transducer from a Philips ultrasound machine. Renal parameters were size, echogenicity, and cortical thickness. Renal echogenicity was graded from 0 to 3 by comparing renal echogenicity to the adjacent liver echogenicity. Radiologists recorded renal parameters and classified the grade of renal echogenicity without knowing the clinical, laboratory findings and biopsy results.

Renal biopsy and histopathologic procedure:

In all patients, sonographically guided renal biopsies were gained from the kidney using a spring-loaded renal biopsy gun. Among 94 cases, 91 biopsies were done from the left kidney, and three biopsies were done from the right kidney. Before performing a renal biopsy, informed written consent was taken from the patient after a proper explanation of the biopsy indication, the procedure of the biopsy, and possible complications. Under the guidance of ultrasonography, percutaneous renal biopsy was performed using a spring-loaded automated solid organ biopsy gun. With all aseptic precautions and proper positioning of the patient, local anesthesia was given. A small incision was made to insert the needle into the lower pole of the kidney to obtain renal tissue. The needle was kept in two separate vials, one containing cooled normal saline and another containing 10% formalin. After the sample was retrieved, pressure was applied to the biopsy site until bleeding ceased. A bandage was applied at the incision site. Patients were followed up regularly to identify any post-procedure complications. All those procedures were uneventful. 31 The biopsy specimens were sent to the Armed Forces Institute of Pathology CMH Dhaka for Histopathology. The biopsy specimen was converted to paraffin-embedded tissues. The section was done 2-3 microns and later stained with hematoxylin and eosin (H&E), periodic acid-Schiff (PAS) reagent, Masson's trichrome, and Jones' methenamine silver stain. Each histology section was analyzed for light microscopy and immunofluorescence to stain immunoglobulin and complement factors. The pathologist evaluates the pathologic findings and classifies the results. Four histological characteristics were evaluated: glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation which were measured from 0 to 5 grade depending on the increasing severity. Although renal sonographic parameters were taken from the right kidney for correlation and echogenicity, and renal biopsies were mainly done from the left kidney, we know that diseases like glomerulonephritis affect both kidneys equally. As the right kidney is just below the liver, comparing the echogenicity of the liver and kidney was helpful.

Data collection:

After the selection of the patient, the aims, objectives, and procedures of the study were explained in understandable language to the patient. Risks and benefits were also made clear to the patients. The patients were encouraged to participate and allowed to withdraw themselves from the study. Then, informed written consent was taken from each patient. A questionnaire was prepared, considering demographic information, relevant history, examination findings, and investigation reports for all the study subjects.

Data analysis:

After collecting all the required data, these were checked, verified for consistency, and tabulated using the SPSS/PC 22. software. Statistical significance is 95% confidence and 5% acceptable error levels. Data were expressed as numbers (percentages) for categorical variables and as mean for continuous variables. The chi-squared test was used to analyze categorical data, and the ANOVA/Unpaired t–test was used to analyze numerical data. To examine relationships between the grade of renal sonographic parameter (Renal size, echogenicity, and cortical thickness) and grade of renal pathology (Glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation), an appropriate statistical test (Spearman's rank correlation coefficient) was used. P-values < 0.05 were considered statistically significant. The renal ultrasonography's diagnostic accuracy was determined using sensitivity, specificity, positive predictive value, and negative predictive value formulas.

- **Sensitivity:** True positive/(True positive+False negative)×100.

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- **Specificity:** True negative/(False positive+True negative)×100.
- **Positive predictive value:** True positive /(True positive+ False positive)×100.
- **Negative predictive value:** True negative/(False negative+True negative) ×100.
- **Accuracy:** (True positive+True negative)/(True positive+False positive+True negative+False negative)×100.

Result

This study involved a total of 94 patients. The age distribution of the patients shows that the most prominent groups are those aged ≤20 and 21-30 years, each comprising 25 patients (26.6%). Just over half (51.1%) of the patients were female, and the rest of the participants were male (Table 1). Table 2 shows that the average length of the right kidney was 9.53 ± 0.78 cm, while the left kidney measured 9.68 ± 0.74 cm. In the right kidney, the mean cortical thickness was 8.54±1.68 mm, and in the left kidney, it was 8.38±1.06 mm.

Additionally, over one-third (38.3%) of patients had cortical echogenicity grade 1. Membranoproliferative glomerulonephritis was the most common diagnosis observed in 21.3% of the study population. This was followed by mesangial proliferative glomerulonephritis, diagnosed in 15 patients (16%), and Immunoglobulin A nephropathy in 11 patients (11.7%) (Table 3). Glomerular sclerosis had a mean value of 16.8, with a standard deviation 28.45. Two-thirds of the patients had no tubular atrophy, interstitial fibrosis, or inflammation (Table 4). Significant associations were observed between the cortical echogenicity of the right kidney and various histopathological parameters. Specifically, higher grades of glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation showed statistically significant correlations with increased cortical echogenicity in the right kidney (Table 5). Statistical analysis revealed significant inter-group variations in glomerular sclerosis among the groups studied. Specifically, Group D (Grade 3) exhibited a significant level of significance (P = 0.001), indicating distinct differences compared to other groups (Table 6). Table 7 exhibits that interstitial inflammation was found to have a significantly increased likelihood, with an OR of 24.83 (95% CI 4.49 to 37.32), leading to the development of cortical echogenicity. However, glomerular sclerosis, tubular atrophy, and interstitial fibrosis were not significantly associated with cortical echogenicity. A statistically significant difference was observed among various grades of tubular atrophy and interstitial fibrosis concerning the length of the right kidney (Table 8). Statistical analysis of inter-group variation in right kidney length (N = 92) revealed significant differences among specific grades of tubular atrophy and interstitial fibrosis. Specifically, Group D demonstrated a statistically significant difference (P = 0.005) in interstitial fibrosis compared to other groups. At the same time, Group E showed significant differences in both tubular atrophy (P = 0.027) and interstitial fibrosis (P = 0.031) compared to Group A (Table 9).

The difference was statistically significant regarding the various grades of tubular atrophy and interstitial fibrosis with cortical thickness of the right kidney (Table 10). The cortical thickness of the right kidney concluded noteworthy observations. Group B exhibited a significant difference (P = 0.006) in interstitial fibrosis compared to Group A. Similarly, Group B also showed significant differences (P = 0.011) in interstitial fibrosis compared to Group C (Table 11). Differences in histopathology at different thresholds for sonographic parameters were statistically significant (Table 12). Of 18 cases identified by Renal USG criteria, 14 were true positives (TP), and 3 were false positives (FP). Conversely, there were four false negatives (FN) and 71 true negatives (TN) among cases not meeting the USG criteria (Table 13).

Table 1: Distribution of the study patients by demographic characteristics (N=94)

Demographic characteristics Age (in years)	Number of patients	Percentage
≤20	25	26.6
21-30	25	26.6
31-40	19	20.2
41-50	15	16
>50	10	10.6
Mean±SD	32.16±13.09	
Sex		
Male	46	48.9
Female	48	51.1

Table 2: Distribution of the study patients by renal sonographic findings (N=94)

USG findings	Right kidney Mean±SD		Left kidney Mean±SD	
Kidney length (cm)	9.53±0.78		9.68±0.74	
Mean difference (cm)	-0.15±.22			
Cortical thickness (mm)	8.54±1.68		8.38±1.06	
Cortical echogenicity	n	%	n	%
Grade 0	13	13.8	-	-
Grade 1	36	38.3	-	-
Grade 2	34	36.2	-	-
Grade 3	11	11.7	-	-

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Table 3: Distribution of the study patients by renal histopathological diagnosis (N=94)

Diagnosis	Number of patients	Percentage
Membranoproliferative glomerulonephritis	20	21.3
Mesangial proliferative glomerulonephritis	15	16
Immunoglobulin A nephropathy	11	11.7
Focal segmental glomerulosclerosis	10	10.6
Lupus nephritis	9	9.6
Minimal change disease	6	6.4
Membranous nephropathy	5	5.3
Chronic sclerosing glomerulonephritis	4	4.3
Immunoglobulin M nephropathy	4	4.3
Diabetic nephropathy	3	3.2
Post-infectious glomerulonephritis	2	2.1
Crescentic glomerulonephritis	2	2.1
Interstitial nephritis	2	2.1
Inadequate sample	1	1.1

Table 4: Distribution of the study patients by specific pathological changes in renal histopathology (N=92)

Histopathology parameter	Number of patients	Percentage
Glomerular sclerosis		
Mean±SD	16.8±28.45	
Tubular atrophy		
Grade 0	60	65.2
Grade 1	3	3.3
Grade 2	14	15.2
Grade 3	10	10.9
Grade 4	3	3.3
Grade 5	2	2.2
Interstitial fibrosis		
Grade 0	60	65.2
Grade 1	8	8.7
Grade 2	14	15.2
Grade 3	7	7.6
Grade 4	2	2.2
Grade 5	1	1.1
Interstitial inflammation		
Grade 0	61	66.3
Grade 1	14	15.2
Grade 2	13	14.1
Grade 3	4	4.3
Grade 4	0	0
Grade 5	0	0

Table 5: Association between cortical echogenicity of right kidney with renal histopathological parameter (N=92)

Histopathological parameter	Cortical echogenicity								P-value
	Grade 0 (n=13)		Grade 1 (n=34)		Grade 2 (n=34)		Grade 3 (n=11)		
	n	%	n	%	n	%	n	%	
Glomerular sclerosis									
Mean±SD	4.5±9.8		8.6±15.4		11.7±22.1		72.2±31.0		a0.001s
Tubular atrophy									
Grade 0	13	100	34	100	13	38.2	0	0	b0.001s
Grade 1	0	0	0	0	3	8.8	0	0	
Grade 2	0	0	0	0	12	35.3	2	18.2	
Grade 3	0	0	0	0	6	17.6	4	36.4	
Grade 4	0	0	0	0	0	0	3	27.3	
Grade 5	0	0	0	0	0	0	2	18.2	
Interstitial fibrosis									
Grade 0	13	100	34	100	13	38.3	0	0	b0.001s
Grade 1	0	0	0	0	8	23.5	0	0	
Grade 2	0	0	0	0	12	35.3	2	18.2	
Grade 3	0	0	0	0	1	2.9	6	54.5	
Grade 4	0	0	0	0	0	0	2	18.2	
Grade 5	0	0	0	0	0	0	1	9.1	

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Interstitial inflammation									
Grade 0	12	92.3	27	79.4	15	44.1	7	63.6	b0.001s
Grade 1	1	7.7	5	14.7	5	14.7	3	27.3	
Grade 2	0	0	2	5.9	11	32.4	0	0	
Grade 3	0	0	0	0	3	8.8	1	9.1	
Grade 4	0	0	0	0	0	0	0	0	
Grade 5	0	0	0	0	0	0	0	0	

Table 6: Statistical analysis (Level of significance) of inter group variation in glomerular sclerosis (N=92)

Group	Level of significance	
Group A	Group B	1.000ns
	Group C	1.000ns
	Group D	0.001s
Group B	Group C	1.000 ns
	Group D	0.001s
Group C	Group D	0.001s
Group A:	Grade 0	
Group B:	Grade 1	
Group C:	Grade 2	
Group D:	Grade 3	

Table 7: Multivariate logistic regression analysis of histopathological parameter with cortical echogenicity as the dependent variable (N=92)

Variables	B	S.E.	OR	95% C.I.		P value
				Lower	Upper	
Interstitial inflammation	3.21	0.87	24.83	4.49	37.32	0.001s
Glomerular sclerosis	0.05	0.045	1.05	0.96	1.14	0.315ns
Tubular atrophy	1.3	8428.91	3.68	1.04	4.1	0.999ns
Interstitial fibrosis	20.31	1008.74	4.62	1.12	3.78	0.998ns

Table 8: Association between renal histopathological parameter and right kidney length (N=92)

Histopathological parameter	Right kidney length (cm) Mean±SD	p-value
Tubular atrophy		
Grade 0	9.7±0.71	0.001s
Grade 1	9.63±0.47	
Grade 2	9.41±0.87	
Grade 3	9.1±0.74	
Grade 4	8.33±0.21	
Grade 5	8.25±0.07	
Interstitial fibrosis		

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Grade 0	9.7±0.71	0.001s
Grade 1	9.45±0.52	
Grade 2	9.46±0.88	
Grade 3	8.67±0.51	
Grade 4	8.15±0.07	
Grade 5	8.3±.0	
Interstitial inflammation		
Grade 0	9.56±0.81	0.830ns
Grade 1	9.36±0.71	
Grade 2	9.54±0.79	
Grade 3	9.38±0.68	
Grade 4	0±0	
Grade 5	0±0	

Table 9: Statistical analysis (Level of significance) of inter group variation in right kidney length (N=92)

Group		Level of significance		
		Tubular atrophy	Interstitial fibrosis	Interstitial inflammation
Group A	Group B	1.000ns	1.000ns	1.000 ns
	Group C	1.000ns	1.000ns	1.000 ns
	Group D	0.268ns	0.005s	1.000 ns
	Group E	0.027s	0.031s	-
	Group F	0.092 ns	1.000 ns	-
Group B	Group C	1.000 ns	1.000ns	1.000 ns
	Group D	1.000 ns	0.372ns	1.000 ns
	Group E	0.444 ns	0.231ns	-
	Group F	0.572 ns	1.000 ns	-
Group C	Group D	1.000 ns	0.181ns	1.000 ns
	Group E	0.295 ns	0.165ns	-
	Group F	0.511 ns	1.000 ns	-
Group D	Group E	1.000 ns	1.000ns	-
	Group F	1.000 ns	1.000 ns	-
Group E	Group F	1.000 ns	1.000 ns	-
Group C	Group D			
Group A:	Grade 0			
Group B:	Grade 1			
Group C:	Grade 2			
Group D:	Grade 3			

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Table 10: Association between cortical thickness of right kidney with renal histopathological parameter (N=92)

Histopathological parameter	Cortical thickness of right kidney (mm) Mean±SD	p-value
Tubular atrophy		
Grade 0	8.52±1.09	0.043s
Grade 1	9.33±1.15	
Grade 2	9.43±3.46	
Grade 3	7.8±0.79	
Grade 4	7.33±0.58	
Grade 5	7±0	
Interstitial fibrosis		
Grade 0	8.52±1.09	0.002s
Grade 1	10.63±4.27	
Grade 2	8.29±0.91	
Grade 3	7.43±0.53	
Grade 4	7±0	
Grade 5	7±0	
Interstitial inflammation		
Grade 0	8.58±1.95	0.735ns
Grade 1	8.36±1.01	
Grade 2	8.77±1.09	
Grade 3	7.75±0.96	
Grade 4	0±0	
Grade 5	0±0	

Table 11: Statistical analysis (Level of significance) of inter-group variation in cortical thickness of right kidney (n=92)

Group		Level of significance		
		Tubular atrophy	Interstitial fibrosis	Interstitial inflammation
Group A	Group B	1.000ns	0.006s	1.000 ns
	Group C	1.000ns	1.000 ns	1.000 ns
	Group D	1.000 ns	0.833ns	1.000 ns
	Group E	1.000 ns	1.000 ns	-
	Group F	1.000 ns	1.000 ns	-
Group B	Group C	1.000 ns	0.011s	1.000 ns
	Group D	1.000 ns	0.002s	1.000 ns
	Group E	1.000 ns	0.043s	-
	Group F	1.000 ns	1.000 ns	-
Group C	Group D	0.291 ns	1.000 ns	1.000 ns
	Group E	0.738 ns	1.000 ns	-
	Group F	0.823 ns	1.000 ns	-
Group D	Group E	1.000 ns	1.000 ns	-
	Group F	1.000 ns	1.000 ns	-
Group E	Group F	1.000 ns	1.000 ns	-
Group A:	Grade 0			
Group B:	Grade 1			
Group C:	Grade 2			
Group D:	Grade 3			

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Table 12: Histopathology at different thresholds for sonographic parameters (N=92)

Parameter	N	Severe chronic kidney disease		P Value
		n	%	
Kidney length <9 cm	24	15	62.5	0.001s
Kidney length ≥9 cm	68	6	8.8	
Echogenicity ≤ less liver	47	1	2.1	
Echogenicity > Liver	45	20	44.4	
Kidney length <9 cm and echogenicity > Liver	17	14	82.4	
Kidney length ≥9 cm and Echogenicity ≤ less liver	42	0	0	

Table 13: Distribution of renal sonographic parameters and renal biopsy in 2/2 contingency table (n=92)

Severe chronic kidney disease determined by Renal USG (Kidney length <9 cm and echogenicity > Liver)	Severe chronic kidney disease determined by gold standard (Renal biopsy)		
	Present	Absent	Total
Present	14(TP)	3(FP)	17
Absent	4(FN)	71(TN)	75
Total	18(TP+FN)	74(FP+TN)	92

Discussion

Glomerulonephritis is a group of kidney diseases characterized by inflammation of the glomeruli, which can lead to progressive kidney damage and end-stage renal disease. Sonography has been widely used as a non-invasive tool to assess renal structure and function. In addition to visualizing a dilated collecting system, sonography provides information on renal size and the thickness and echogenicity of the renal cortex. However, its ability to accurately predict histopathological changes in glomerulonephritis remains debatable [13]. This study aims to correlate renal sonographic findings with histopathological features in patients diagnosed with glomerulonephritis. In this study, the distribution of the study patients by demographic characteristics showed that one-fourth (26.6%) of patients belonged to age ≤20 years. The mean age was 32.16±13.09 years. Half, 48(51.1%) patients were female and 46 (48.9%) were male. In our study, Dahal et al. reported that the mean age of the participants was 32.4 years. Out of 54 patients, 30(55.56%) were male and 24(44.44%) were female [12]. Male to female ratio was 1.25:1, which was comparable to our study. Regarding the distribution of the study patients by renal USG findings, our study observed that the mean kidney length was 9.53±0.78 cm in the right kidney and 9.68±0.74 cm in the left kidney. The mean cortical thickness was 8.54±1.68 mm in the right kidney and 8.38±1.06 mm in the left kidney. Over one-third (38.3%) of patients had cortical echogenicity grade 1. The mean difference between the right and left kidney was -0.15±0.22 cm. In one study, Dahal et al. reported that the mean length of the right kidney was 9.8 cm with a standard deviation of 0.8 cm [12]. The left kidney's mean renal length was 10.1cm, with a standard deviation of 1 cm. The mean length differences between the two kidneys were 0.2 cm with a standard deviation of 0.5cm due to the slightly larger left kidney, which is a normal finding. Although this report differed very little from our study, it was comparable. This variation may be due to geographical and racial variation [14]. According to our observation, 20(21.3%) patients had membranoproliferative glomerulonephritis followed by mesangial proliferative glomerulonephritis 15(16%), immunoglobulin A nephropathy 11(11.7%), Moghazi et al. noted among 207 study population 55 are proliferative glomerulonephritis which is consistent with our study. In our study, proliferative glomerulonephritis was found to be more common [13]. Our study found that specific pathological changes in renal histopathology were glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation. Glomerular sclerosis, tubular atrophy, and interstitial fibrosis were chronic and irreversible that were. Vascular changes were not considered in our study. Lee et al. noted that vascular changes were not specific in all pathologic findings [5]. Sethi et al. also concluded that chronic changes are much less consistently found with arteriosclerosis in renal histopathology [15]. For echogenicity and correlation, the renal sonographic parameter was measured from the right

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kidney, and a biopsy was taken mostly from the left kidney. It was thought that the disease condition affected both kidneys equally. Moreover, intervals between renal sonography and biopsy were ranged from 1-10 days. Because of more delay between renal sonography and biopsy, acute conditions subsided, and many acute findings in renal histopathology may missed [15]. In this current study, there was an association between cortical echogenicity of the right kidney with all renal histopathological parameters (glomerular sclerosis, tubular atrophy, interstitial fibrosis, and interstitial inflammation), and the p-value was significant ($p<0.05$). A multivariate analysis was performed in our study to observe the relative contribution to the echogenicity of renal histopathological parameters. It showed that only interstitial inflammation was a significant independent contributor, which was statistically significant ($p<0.05$). Interstitial inflammation significantly increased 24.83 times, leading to the development of cortical echogenicity (95.0% C.I. 4.49 to 37.32). So, echogenicity may be increased in interstitial inflammation, a reversible acute condition [15]. Moghazi et al. also found that cortical echogenicity positively correlated with all renal histopathological parameters, and multivariate analysis showed tubular atrophy and interstitial inflammation as significant independent contributors to renal cortical echogenicity [13]. This was comparable to our study, but interstitial inflammation was a significant independent contributor to echogenicity. This discrepancy might be due to the smaller sample size in our study. There was an inverse association between right kidney length with interstitial fibrosis and tubular atrophy, which was statistically significant ($p<0.05$) but not with interstitial inflammation ($p>0.05$). Moghazi et al. also showed renal size negatively correlated with glomerular sclerosis, tubular atrophy, and weakly with interstitial fibrosis; r values were -0.26, -0.20, and -0.14, respectively [13]. This study found a significant association between cortical thickness with tubular atrophy and interstitial fibrosis but not with interstitial inflammation. Moghazi et al. showed that cortical thickness did not correlate with histopathological parameters [13]. Which was not consistent with our findings. Marchal et al. mentioned that the composition of the cortex of a normal kidney was by glomeruli, which were radially oriented and separated by convoluted tubuli of primary and secondary order and interspersed interstitium [16]. They also mentioned interstitial fibrosis of the medulla, which can be considered physiologic, but interstitial fibrosis in the cortex always points to pathology. Severe chronic kidney disease is considered if >50% sclerosed glomeruli or a score of 3 out of 5 or greater for tubular atrophy or interstitial fibrosis were found in renal histopathology [13]. To determine the utility of renal sonography for detecting irreversible renal parenchymal disease, different thresholds for sonographic parameters were compared with >50% sclerosed glomeruli or a score of 3 out of 5 or greater for tubular atrophy or interstitial fibrosis at renal histopathology. In our study, histopathology at different thresholds for sonographic parameters showed that almost two-thirds (62.5%) of patients had severe chronic kidney disease in kidney length <9 cm and 8.8% in kidney length ≥9 cm. Severe chronic kidney disease was present in 2.1% of echogenicity ≤ liver and 44.4% in echogenicity > liver ($p< 0.001$). Severe chronic kidney disease was present at 82.4%. and 0% in together kidney length <9 cm echogenicity > liver and kidney length ≥9 cm, echogenicity ≤ liver respectively ($p< 0.001$). Moghazi et al. also found that severe chronic kidney disease was present in 69% and 47% of patients with combined renal length <20 cm and >20 cm, respectively (P= <0.05). For cortical echogenicity >1.0 (>liver echogenicity) and ≤1.0 (echogenicity ≤ liver), the proportions of severe disease were 66% and 30%, respectively ($P < 0.001$). Severe disease was present in 86% of patients with combined renal length <20 cm and cortical echogenicity >1.0 ($P < 0.001$) [13]. Which was comparable to our study. Our study determined that the threshold for kidney size is 9 cm. Another study described cadaveric mean kidney length as 8.99cm [17]. Our findings showed severe chronic kidney disease was present in only 62.5% if only kidney length < 9cm and 44.4% if only echogenicity > liver. This finding exhibited that kidney length or echogenicity alone was not a good predictor of severe chronic kidney disease. Because only kidney size or increased echogenicity could cause severe chronic kidney disease. Moreover, increased echogenicity may present in both acute and chronic conditions [11], and in this study earlier, we mentioned that interstitial inflammation is an independent determinant of increased echogenicity in multivariate analysis. When inflammation resolves, echogenicity may decrease. This may be a possible explanation for the temporary increase in echogenicity. However, kidney length <9 cm and echogenicity > liver can predict severe chronic kidney disease in 82.4% of cases with 77% sensitivity, 94% specificity, a PPV of 82%, NPV of 94.66% with 92% accuracy.

Limitations of the study

This study's limitations include a small sample size of 94 patients, hindering broader generalizability beyond Dhaka Medical College Hospital. Its cross-sectional design limits causal inference between renal sonographic parameters and histopathology, necessitating longitudinal studies. Reliance on left kidney biopsies versus right kidney sonographic data introduces bilateral variability. Variations in timing between sonography and biopsy may affect the correlation between acute findings. The focus on specific histopathological parameters may overlook other renal pathologies.

Conclusion and Recommendations

Renal cortical echogenicity is the sonographic parameter most closely correlates with histopathological findings. Increased cortical echogenicity may indicate both acute

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and chronic conditions. Measuring cortical thickness is also valuable, but size or echogenicity alone are poor predictors of chronic irreversible kidney disease. However, when combined, they effectively predict chronic irreversible renal parenchymal disease. Further multicentric studies with larger sample sizes and stratified by histopathological and ultrasonographic determinants are needed to establish the correlation between renal sonographic findings and the histopathology of glomerulonephritis patients. As this is a cross-sectional study, follow-up research is needed to evaluate whether renal cortical echogenicity resolves when acute conditions subside.

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References

1. Haq MN, Raaman L, Miah MZ, et al. Epidemiological Pattern of Renal Insufficiency among the Patients of Nephrology Unit of Dhaka Medical College Hospital, Dhaka, Bangladesh. Faridpur Medical College Journal 8 (2013): 80-84.
2. Levin A, Stevens PE, Bilous RW, et al. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney international supplements 3 (2013): 1-50.
3. Lees JS, McQuarrie EP, Mackinnon B. Renal biopsy: it is time for pragmatism and consensus. Clinical Kidney Journal 11 (2018): 605-609.
4. Abdel-Hafez M, Shimada M, Lee PY, et al. Idiopathic nephrotic syndrome and atopy: is there a common link?. American Journal of Kidney Diseases 54 (2009): 945-953.
5. Lee JH, Cho MH, Chung SI, et al. Relationship of renal echogenicity with renal pathology and function. Childhood Kidney Diseases 21 (2017): 47-52.
6. Libório AB, de Oliveira Neves FM, Torres de Melo CB, et al. Quantitative renal echogenicity as a tool for diagnosis of advanced chronic kidney disease in patients with glomerulopathies and no liver disease. Kidney and Blood Pressure Research 42 (2017): 708-716.
7. Luciano RL, Moeckel GW. Update on the native kidney biopsy: core curriculum 2019. American Journal of Kidney Diseases 73 (2019): 404-415.
8. O'Neill WC. Renal relevant radiology: use of ultrasound in kidney disease and nephrology procedures. Clinical Journal of the American Society of Nephrology 9 (2014): 373-381.
9. Lucisano G, Comi N, Pelagi E, et al. Can renal sonography be a reliable diagnostic tool in the assessment of chronic kidney disease? Journal of Ultrasound in Medicine 34 (2015): 299-306.
10. Chi T, Feldstein VA, Nguyen HT. Increased echogenicity as a predictor of poor renal function in children with grade 3 to 4 hydronephrosis. The Journal of urology 175 (2006): 1898-1901.
11. Manley JA, O'Neill WC. How echogenic is echogenic? Quantitative acoustics of the renal cortex. American journal of kidney diseases 37 (2001): 706-711.
12. Dahal S, Pandit SP, Khadka HA, et al. Renal Parenchymal Disease: sonographic histopathology correlation. Post-Graduate Medical Journal of NAMS 14 (2014).
13. Moghazi S, Jones E, Schroepple J, et al. Correlation of renal histopathology with sonographic findings. Kidney international 67 (2005): 1515-1520.
14. Arooj A, Lam J, Wui YJ, et al. Comparison of renal size among different ethnicities. Int J Biol Biomed Eng 5 (2011): 221-229.
15. Sethi S, D'Agati VD, Nast CC, et al. A proposal for standardized grading of chronic changes in native kidney biopsy specimens. Kidney international 91 (2017): 787-789.
16. Marchal G, Verbeken E, Oyen R, et al. Ultrasound of the normal kidney: a sonographic, anatomic and histologic correlation. Ultrasound in medicine & biology 12 (1986): 999-1009.
17. Khatun H, Sultana Z, Kibria GM. Morphological study of the kidney in relation to age. Bangladesh Journal of Anatomy 7 (2009): 19-21.