

Sonographic Findings in Renal Parenchymal Diseases at Sudanese

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Abstract

Objective: The objective of this study was to assess the sonographic findings in renal parenchymal diseases using gray-scale ultrasound in order to classify these diseases. The study design was a cross-sectional one. There were 204 patients who were suspected with renal diseases. They had been scanned with ultrasound to assess the kidneys. The echogenicity, renal cortex and parenchyma, and cortico-medullary differentiation had been evaluated. **Results:** The study revealed that the echogenicity of renal parenchyma and cortex increased in all types of renal parenchymal diseases. The cortico-medullary differentiation was mainly disturbed in acute parenchymal disease (69.04%), loss in chronic end-stage parenchymal disease (85%); and there was significant difference (p -value = 0.0001). **Conclusion:** Ultrasound provided useful and accurate diagnosis of renal parenchymal diseases. In this study, renal parenchymal diseases had been classified into acute, chronic and end-stage renal parenchymal diseases.

Keywords

Renal, Parenchymal, Diseases, Sonographic, Findings, Sudanese

1. Introduction

Ultrasonography of the kidneys has become the most routine investigation in radiology departments. The renal parenchymal diseases are most common causes of acute and chronic renal diseases which may lead to end stage renal diseases if it doesn't manage and treat properly. The treatment of these cases if it develops is very expensive and it

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may be fatal if it is ignored. The purpose of this study is to evaluate the renal changes that associate with renal parenchymal diseases using ultrasound. Assessment of renal size, site and echogenicity can be easily determined.

Renal masses such as solid tumors can be detected and can be distinguished from renal cysts. Ultrasonography can detect nephrolithiasis and hydronephrosis. Dilated ureters can frequently be followed up to the location of the occluding concrement. The majority of renal parenchymal diseases can be classified and differentiated by ultrasonography. However, the experienced investigator can almost always distinguish normal from diseased kidneys. Detection of renal arteries is reliably possible with Color Doppler sonography [1]. Renal parenchymal diseases can be classified as uni- or bilateral diseases with small, large or normal sized kidneys. A general rule is that small kidneys depict chronic renal disease and enlarged or at least normal sized kidneys depict acute and therefore potentially reversible disease. Echogenicity is an important distinguishing sonographic parameter to evaluate renal parenchyma. Diseased kidneys in general show hyperechoic, however in the early stages echogenicity may still be normal. Increasing echogenicity is directly correlated to histopathological findings such as global sclerosis, tubular atrophy, leukocyte infiltration and the number of hyaline casts per glomerulum. Decreased echogenicity is correlated to the magnitude of interstitial edema [1].

Renal parenchymal diseases include a large number of diseases affecting the renal parenchyma and produce renal failure. Rosenfield *et al.* divided the diseases of renal parenchyma into those that accentuate cortical echoes but preserve or exaggerate the corticomedullary junction (type i) and those that distort the normal anatomy and obliterate the corticomedullary differentiation in either a focal or diffuse manner (type ii). In type (i), the echogenicity of renal cortex is equal to or greater than liver or spleen. Minor signs include the loss of identifiable arcuate vessels or the accentuation of corticomedullary definition. In type (ii), changes can be seen in focal disruption of normal anatomy with any mass lesion including cyst, tumor, abscesses, and hematoma [2] [3].

Previous studies have shown that renal volume calculated at ultrasound is a more exact measurement of a functioning kidney than renal length [4] [5].

Hypertension is regarded as one of the common cause of renal parenchymal diseases. In this study, we observe that it is the second cause of renal parenchymal diseases. Most of renal diseases are associated with hypertension. This association is most prominent with glomerular diseases, including diabetic nephropathy (DN) and membranoproliferative glomerulonephritis (MPGN), in which 70% to 80% of patients are affected [6].

2. Materials and Methods

There were 204 patients above 20 years old suffering from impaired renal functions came to different hospitals in Khartoum State, Sudan, during the period from 2009 up to May 2013. The study was conducted in following hospitals; Ibn Sina, Khartoum teaching hospital, Advance Diagnostic Centre in Khatoum East and Nile Model hospital. A data collection sheet was designed to include the demographic data and clinical history of every patient. Informed consent was given to every patient. The clinical history of every patient had been reported. Patients with known history of renal masses had been excluded from the study. The inclusion criteria included all-patients who had been confirmed suffering from impaired renal function. The study was approved by the local Ethics Committee of faculty of radiological sciences and medical imaging.

2.1. Ultrasound Technique

Using a standard B mode gray-scale ultrasound, patients were scanned using Toshiba ultrasound machine with multi-frequency curvilinear probes (3.5 - 5 MHz) which have variable focal zones and frequency capabilities, and AlokaProsound SSD-3500sx with two probes curvilinear probe 3.5 MHz and linear high frequency 7.5 MHz probe. Proper setting of the overall gain (system) gain and time gain or depth gain compensation (TGC/DGC) was adjusted to optimally visualize each kidney. Each patient was scanned twice, firstly by the researcher and then by consultant radiologists to confirm the findings and diagnosis following the international scan guidelines and protocols. Longitudinal, transverse and coronal sections were taken through the kidneys. Low tissue harmonic imaging was applied to visualize the liver, spleen and kidney in order to assess the echogenicity. Then, the echogenicity of renal cortex and parenchyma was compared with liver and spleen. When there was inter observer variation, consensus was sought.

2.2. Statistical Analysis

The data had been analyzed using appropriate statistical tests using SPSS version 16. The significant test value

was 5%, all values less than 5% were regarded to be significant. Chi-square test was had been applied to find association between qualitative variables, e.g. degree of association between types of renal parenchymal diseases and corticomedullary differentiation.

3. Results

All patients were referred to ultrasound department for renal ultrasound examinations. It was observed that 82 patients had no clinical history (39.81%) as shown in **Table 1**. Hypertension and diabetes were the most common diseases that associated with renal parenchymal disease and represent 33.01% and 7.77% respectively. It was noted that renal parenchymal diseases were mostly common at the age under 30 years old as shown in **Table 2**. Significant difference was existent between age and prevalence of the renal parenchymal diseases (p -value = 0.0046). The gender distribution of the study population revealed that acute renal parenchymal affect males and females equally (50% vs. 50% respectively). But in chronic and end-stage parenchymal diseases, males were more affected than females (66.67% vs. 33.33% and 63.33% vs. 36.67% respectively) as shown in **Table 3**.

Table 1. Frequency distribution of patients according to clinical history.

History	Frequency	%
No patient history	82	39.81
Hypertension	68	33.01
Diabetic	16	7.77
Diabetic and hypertensive	10	4.85
Others	6	2.91
Renal stone	6	2.91
Recurrent UTI	2	0.97
Recurrent malaria	2	0.97
Gouty arthritis	2	0.97
Preeclampsia	2	0.97
Lupus erthromatosus	2	0.97
Renal cell carcinoma	1	0.48
Mesangiocapillary glomerulonephritis	1	0.48
Carcinoma of U-bladder	1	0.48
Right kidney chronic obstruction	1	0.48
Bloody diarrhea	1	0.48
Atherosclerosis	1	0.48
Recurrent abortion	1	0.48
Sickle cell anemia	1	0.48
Total	204	100

Table 2. Age distribution of the study population.

Gender	Type of renal parenchymal diseases					
	Acute renal parenchymal ($n = 84$)		Chronic renal parenchymal ($n = 60$)		Chronic end stage renal ($n = 60$)	
	No.	%	No.	%	No.	%
Males	42	50.00	40	66.67	38	63.33
Females	42	50.00	20	33.33	22	36.67
Total	84	100	60	100	60	100

The results showed that workers were mostly affected with renal parenchymal diseases among the study population (27.38% with acute renal parenchymal disease, 45% with chronic parenchymal diseases and 40% with chronic end-stage kidney diseases. Then housewives were the second group involved with renal parenchymal diseases (33.33% with acute renal parenchymal disease, 24.34% with chronic parenchymal disease and 21.67% with chronic parenchymal disease) as shown in **Table 4**. The echogenicity of the renal parenchyma had been categorized into four grading; hyperechoic, hypoechoic, normal and high echogenic. Increased echogenicity is an important sonographic parameter that had been changed in renal parenchymal diseases among the study population. In **Table 5**, the results revealed that increased echogenicity of renal parenchyma was 84.52% in patients with acute renal parenchymal diseases, 96.67% in patients with chronic renal parenchymal disease and 100% at end stage renal diseases. Results of **Table 6** revealed that increased echogenicity of renal cortex was 84.52% in patients with acute renal parenchymal diseases, 96.67% in patients with chronic renal parenchymal disease and 100% at end stage renal diseases. The corticomedullary differentiatin (CMD) was changed in renal parenchymal diseases; this change depends on prolonged of pathological condition (**Table 7**). We used Chi-square test to find association between types of renal parenchymal diseases and CMD. Values <0.05 indicate there was significant association. **Figure 1** and **Figure 2** showed ultrasound images of the diseased kidneys.

Table 3. Occurrence of renal parenchymal diseases in males and females of the study population.

Age groups(years)	Type of renal parenchymal diseases						p-value
	Acute renal parenchymal (n = 84)		Chronic renal parenchymal (n = 60)		Chronic end stage renal (n = 60)		
	No.	%	No.	%	No.	%	
<20	20	23.81	3	5.00	5	8.33	0.0046**
20 - 30	20	23.81	11	18.33	13	21.67	
31 - 40	17	20.24	8	13.33	18	30.00	
41 - 50	7	8.33	6	10.00	10	16.67	
51 - 60	8	9.52	11	18.33	6	10.00	
>60	12	14.29	21	35.00	8	13.33	
Total	84	100	60	100	60	100	

Table 4. Frequency distribution of patients according to occupation and type of renal parenchymal diseases.

Occupation	Type of renal parenchymal diseases					
	Acute renal parenchymal (n = 84)		Chronic renal parenchymal (n = 60)		Chronic end stage renal (n = 60)	
	No.	%	No.	%	No.	%
Worker	23	27.38	27	45.00	24	40.00
Employee	21	25.00	8	13.33	6	10.00
No occupation	12	14.29	11	18.33	17	28.33
Housewife	28	33.33	14	24.34	13	21.67
Total	84	100	60	100	60	100

Table 5. Grading of renal parenchymal echogenicity at renal parenchymal diseases.

Renal parenchymal echogenicity)	Type of renal parenchymal diseases					
	Acute renal parenchymal (n = 84)		Chronic renal parenchymal (n = 60)		Chronic end stage renal (n = 60)	
	No.	%	No.	%	No.	%
Hyperechoic	71	84.52	58	96.67	60	100
Hypoechoic	2	2.38	-	-	-	-
Normal	9	10.71	2	3.33	-	-
Highly echogenic	2	2.38	-	-	-	-
Total	84	100	60	100	60	100

Table 6. Grading of renal cortical echogenicity at renal parenchymal diseases.

Renal cortical echogenicity	Type of renal parenchymal diseases					
	Acute renal parenchymal (n = 84)		Chronic renal parenchymal (n = 60)		Chronic end stage renal (n = 60)	
	No.	%	No.	%	No.	%
Hyperechoic	71	84.52	58	96.67	60	100
Hypoechoic	2	2.38	-	-	-	-
Normal	9	10.71	2	3.33	-	-
Highly echogenic	2	2.38	-	-	-	-
Total	84	100	60	100	60	100

Table 7. Changes of corticomedullary differentiation at renal parenchymal diseases.

Corticomedullary differentiation	Type of renal parenchymal diseases						p-value
	Acute renal parenchymal (n = 84)		Chronic renal parenchymal (n = 60)		Chronic end stage renal (n = 60)		
	No.	%	No.	%	No.	%	
Preserved	12	14.29	10	16.67	1	1.67	0.0001
Lost	14	16.67	10	16.67	51	85.00	
Disturbed	58	69.04	40	66.66	8	13.33	
Total	84	100	60	100	60	100	

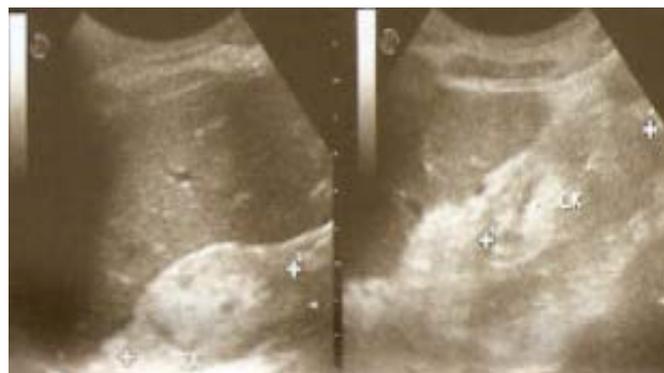


Figure 1. Small hyperechoic kidney with loss of cortico-medullary differentiation in patient with chronic renal failure.



Figure 2. Shows enlarged hypoechoic kidney in acute renal parenchymal disease in a patient with Systemic Lupus Erythematosus.

4. Discussion

Renal parenchymal diseases are one of the most common health problems that cause severe morbidity and mortality. Ultrasound is an essential imaging method for the evaluation of patients presented with renal diseases especially for end-stage kidney diseases. Correlation with renal biopsy is necessary to confirm the final accurate diagnosis. There were several authors have studied sonographic renal parameters in an attempt to establish their relevance in evaluation of specific renal disease processes [7]. In this study, 204 patients with confirmed renal parenchymal disease were examined. It was observed that 39.81% of the patients had no clear history. The disease progresses silently until the symptoms appear. In this study diabetes and hypertension were the most common causes of renal parenchymal diseases. Hypertension is strongly related to renal parenchymal diseases. Most primary renal diseases alter electrolytes balance and volume control and this may cause clinical hypertension. Preston *et al.* concluded that renal parenchymal diseases were common causes of hypertension. Chronic kidney disease and systemic hypertension were interrelated. However persistent hypertension is an essential cause of chronic renal disease while renal parenchymal diseases were common causes of secondary hypertension [8]. In our study we found that hypertension was the most common finding (68%) in the study sample and this was attributed to the renal parenchymal diseases. The present study showed that diabetes is the second cause of renal parenchymal disease. This finding is consistent with a study performed on diabetic nephropathy which reported that, diabetes mellitus (type 1 and 2) affect the renal function such as glomerular filtration and renal volume. Kidney volume is reduced in the late stage. Diabetes also influences renal vascularity and alter Doppler indices such as resistive index (RI) values [9].

The sonographic findings of the kidneys had been evaluated in the present study. The sonographic evaluation provides accurate and precise values (high positive predictive values) for assessing renal parenchymal disease [10]. In our study, we found that the echogenicity of renal parenchyma and cortex were both equally and grossly increased in acute, chronic and end-stage parenchymal diseases. Increased echogenicity of renal cortex has proven to be significantly related to various parenchymal pathological changes such as tubular atrophy, fluid retention, arteriosclerosis and hyaline cylinders [11] [12]. Fiegler *et al.* [13] reported that the echogenicity of the renal parenchyma was correlated with glomerular and interstitial findings. There was a significant correlation between echogenicity of the renal parenchyma and prolonged pathological processes of the renal parenchyma. This result was consistent with our study which revealed that renal cortex and parenchyma were both hyperechoic. Therefore, echogenicity is a necessary sonographic parameter which is capable of classifying and progression of the parenchymal diseases.

5. Conclusion

The ultrasound plays a great role in evaluation of renal parenchymal diseases. It is capable to differentiate renal parenchymal diseases and this enables their follow-up and facilitates the choice of appropriate medication and treatment.

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