ORIGINAL RESEARCH PAPER

Radiodiagnosis

"ROLE OF ULTRASONOGRAPHY IN EVALUATION OF PATIENTS WITH RENAL FAILURE"

KEY WORDS: renal ultrasound- gray scale and duplex doppler; AKI, CKD.

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ABSTRACT

Introduction: Kidney failure do not cause specific symptoms which leads to their delayed diagnoses, resulting in patients admitted only with elevation in serum urea and creatinine. Ultrasonography of the kidneys is essential in the diagnosis and management of kidney-related diseases. **Aim:** To investigate the potential utility of renal Ultrasonography to distinguish acute from chronic renal failure. **Materials and methods:** Patients were subjected to USG Whole Abdomen on GE LOGIQ F8 EXPERT and GE VOLUSON S8 sonography machines. Proper setting of the overall gain – system gain and TGC/DGC was adjusted to optimally visualize each kidney. **Results:** combined gray scale and color doppler has higher sensitivity, specificity, PPV, NPV rather than just gray scale or color doppler USG in isolation. **Conclusion:** USG plays a great role in evaluation of patients with ARF and CKD. Duplex color doppler plays a major role as it can detect damage to renal parenchymal vascular resistance.

INTRODUCTION

Kidney diseases do not cause specific symptoms which leads to delayed diagnoses. Therefore, many patients admit only with elevation in serum urea and creatinine which necessitates determining the acuity of the event. If it is documented to be normal a few days previously the patient labelled as an acute kidney injury, whereas a patient who presents with a previously elevated serum creatinine that has been rising gradually over the past several months may easily be labelled as a chronic kidney disease. However, the distinction between acute kidney injury (AKI) and chronic kidney disease (CKD) may be difficult in cases with no recent measurements of serum creatinine.[1]

Acute kidney injury (AKI) is common among hospitalized patients with a reported prevalence of 2 to 35%. Acute renal failure is a sudden and sustained decrease in the glomerular filtration rate associated with a loss of excretory function and the accumulation of metabolic waste products and water. It leads to an increase in serum urea and creatinine usually with a decrease in urine output.[2]

A history of the factors that may cause AKI such as events associated with volume loss, sepsis, recent surgery, nephrotoxic medications, signs of heart and liver failure, herbal medication, and obstructive urologic disorders.[3,4]

Chronic kidney disease (CKD), also known as chronic renal failure, is a progressive loss of glomerular function caused by a long-standing renal parenchymal disease. It is present when the glomerular filtration rate (GFR) is less than 60 ml/min/1.73 m^2 for three consecutive months or greater than or equal to this value in patients with a kidney damage that is present for three or more months.[5] CKD is a prevalent disease, affecting between 10-15% of the adult population globally.[6] Long duration diabetes, hypertension, polycystic kidney disease, urologic disorders, and refractory nephritis should be included in medical history. The ultrasound images in chronic renal failure show a smaller kidney, thinning of the parenchyma and its hyper echogenicity (reflecting sclerosis and fibrosis).[7]

Sonography is the preferred modality of imaging in suspected cases of acute and chronic renal diseases. The ease of performing the sonography with the advantage of reliability, affordability, availability, acceptability, lack of ionizing radiation, no need of intravenous contrast as it may be deleterious to the already damaged kidneys, portability with option of conducting investigation at patient's bedside and repeatability makes sonography as the most useful investigating tool in evaluating renal diseases.[8]

After conventional US evaluation, Doppler US (DUS) and resistive indices (RIs) analysis provide renal functional evaluation.[9]

MATERIALS AND METHODS

The study is conducted in Department of Radiodiagnosis, Sri Aurobindo Medical College & Post Graduate institute, Indore (M.P.), India, from October 2019 to November 2020, after approval from institutional research & ethical committee.

All patients referred to our department from various department of our institute with clinical diagnosis of renal failure were subjected to USG Whole Abdomen on GE LOGIQ F8 EXPERT and GE VOLUSON S8 sonography machines. Proper setting of the overall gain – system gain and TGC/DGC was adjusted to optimally visualize each kidney. Longitudinal, transverse and coronal sections were taken through the kidneys. Mean and Percentage were used to represent the data.

RESULTS

A total of 200 patients who presented with deranged renal function tests were included in our study. Mean age of patients in our study was **46.645 ± 16.345,** with maximum number of patients in age group pf 46-60years followed by 31-45years (Table 1). No significant sex predilection was observed in our study, with 53.5% patients being male and 46.5% patients being female (Graph 1).

In our study, majority of the patients were hypertensive (31%), followed by those who had both hypertension and diabetes mellitus USG (18%). (Table 2).

In our study, there were total 85 patients with small renal size (i.e. <8.5cm) out of which 85% patients were diagnosed as CKD and 15% patients diagnosed as ARF. Out of 95 patients in the normal range for renal size (i.e. 8.6-11.5cm), 84% were diagnosed as ARF and 16% as CKD. A total of 20 patients had large renal size (i.e. >11.6cm) all of which were diagnosed as ARF. (Table 3).

In our study, there were 11 patients who had echogenicity less than that of liver and all were diagnosed as ARF. We had 41 patients with echogenicity equal to liver, out of which 73% patients were diagnosed as ARF, and 27% as CKD. Out of 148 patients who had echogenicity more than that of liver, 48%

were ARF patients and 52% were CKD patients.

Of the total patients diagnosed as ARF on USG , echogenicity was raised(equal to and more than liver) in 90% patients.Of the total patients diagnosed as CKD on USG , echogenicity was raised(equal to and more than liver) in 100% patients. (Table 3).

In our study, exaggerated CMD was found in 23 patients of which all were diagnosed as ARF. We found 95 patients with maintained CMD, of which 79% were diagnosed as ARF , and 21% were diagnosed as CKD. We had 53 patients with poorly maintained CMD , of which 26% were diagnosed as ARF and 74% were diagnosed as CKD. We had 29 patients with lost CMD all of which were diagnosed as CKD.

Out of the total patients diagnosed as ARF on USG, maximum patients had maintained CMD and we did not find any ARF patient to have lost CMD on USG. Out of the total patients diagnosed as CKD on USG, maximum patients had poorly maintained CMD followed by lost CMD, and we did not find any CKD patient to have exaggerated CMD on USG.(Table 3).

In our study, we had 50 patients with thickened renal parenchyma all of which were diagnosed as ARF.Of the 94 patients with normal renal parenchyma, 65% were diagnosed as ARF and 35% were diagnosed as CRF. We had 56 patients with thinning of renal parenchyma of which 3% were diagnosed as ARF and 97% as CKD.

Out of the total patients diagnosed as ARF on USG, maximum patients had normal renal parenchyma followed by swollen parenchyma. Out of the total patients diagnosed as CKD on USG, maximum patients had thinned out renal parenchyma, followed by normal parenchyma, and we did not find any CKD patient to have thickened parenchyma on USG. (Table 3).

In our study, we had 89 patients with normal resistive index of which 80% were diagnosed as ARF and 20% were diagnosed as CKD. Of the 111 patients with raised resistive index, 31% were diagnosed as ARF and 69% were diagnosed as CRF.

Out of the total patients diagnosed as ARF on USG, maximum patients (67%) had normal resistive index. Out of the total patients diagnosed as CKD on USG, maximum patients (81%) had raised resistive index. (Table 3).

In our study, we were able to diagnose 113 (56.5%) patients with ARF on the basis of gray scale ultrasonographic features.

Similarly, we were able to diagnose 87 (43.5%) patients with CKD on the basis of gray scale ultrasonographic features.

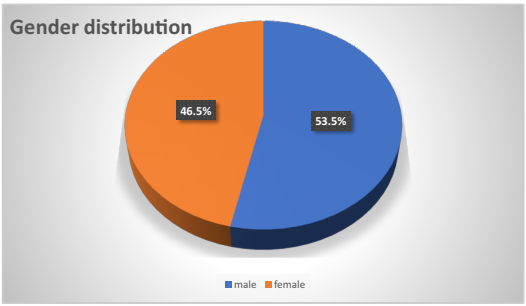
On the basis of cumulative sonographic features, that is on gray scale and duplex color doppler USG, a total of 107(53.5%) patients were diagnosed as ARF and 93 (46.5%) patients were diagnosed as CKD (Table 4).

Statistically significant difference was found in renal sizes, thinning of renal parenchyma and color doppler (RI)values. (Table 3)

Therefore, we conclude that, combined gray scale and color doppler has higher sensitivity, specificity, PPV, NPV rather than just gray scale or color doppler USG in isolation. (Table 5).

Table:1 Distribution of patients on the basis of age.

S.NO.	AGE (years)	No. of patients (N=200)	Percentages (%)
1	<15	11	5.5
2	16-30	19	9.5
3	31-45	62	31
4	46-60	71	35.5
5	>60	37	18.5
	TOTAL	200	100



Graph:1 Distribution of patients on the basis of gender.

Table 2: Distribution of associated relevant medical illness among subjects.

S.NO	Etiology	No.of patients (N=200)	Percentages (%)
1	HTN	62	31
2	DM	30	15
3	HTN+DM	36	18
4	Dehydration	29	14.5
5	Obstructive	13	6.5
6	Others	30	15
		200	100

Table 3: Cumulative sonographic features in patients with ARF and CKD.

USG findings	ARF	CKD	P value
1. Size of kidneys (cm)			
<8.5	13	72	<0.001
8.6-11.5	80	15	<0.001
>11.6	20	0	<0.001
2. Echogenicity			
Less than liver	11	0	<0.001
Equal to liver	30	11	0.134
More than liver	72	76	0.004
3. CMD			
Exaggerated	23	0	<0.001
Normal/maintained	76	19	0.121
Poorly maintained	14	39	0.101
Lost	0	29	<0.001
4. Renal Parenchyma/ cortex			
Thickened	50	0	<0.001
Normal	61	33	0.007
Thinning	2	54	<0.001
5. Renal Doppler			
Normal (RI </= 0.7)	72	17	<0.001
Raised (>0.7)	35	76	<0.001

Table 4: Distribution of diseased patients according to diagnosis on basis of gray scale USG, combined gray scale and Duplex color doppler USG and final diagnosis.

Disease	Gray scale USG	Gray scale + color doppler USG	Final diagnosis
ARF	113(fp-10, fn-2)	107(fp-3, fn-1)	105
CKD	87 (fp-3, fn-11)	93 (fp-5, fn-3)	95
	200	200	200

Table 5: Statistical analysis of sonographic diagnosis.

Pathology	Imaging	Sensitivity	specificity	PPV	NPV	Accuracy
ARF	Gray scale	98.13 %	90.48%	91.30%	97.94%	94.34%
	Gray scale + color doppler	99.06 %	96.94%	97.22%	98.96%	98.04%

CKD	Gray scale	89.62 %	97.22%	96.94%	90.52%	93.46%
	Gray scale + color doppler	96.94 %	95.45%	95.00%	97.22%	96.15%

DISCUSSION

In our study, we found the most common age group involved was 46-60 years, which contributed 35.5% patients in our study. We did not find any significant difference in gender involvement. According to Noor-ul Amin and others[10] studies it was also observed that CKD is more common in male then in female. People between 40 to 60 years are more affected with CKD. The reason may be attributable to hypertension, diabetes or some other age-related changes. It was also observed that middle age males are more affected to CKD disease.

Leila Malekmakan et al[11], conducted a study in southern Iran , and found that the Prevalence of CKD stages III–V was 27.5% in the 60–69 years age group, 36.5% in the 70–79 years age group, and 40% in the ≥80 years age group.

In our study, we found the most common cause for renal failure being hypertension (31%) followed by combined hypertension and diabetes mellitus, which was consistent with a study done by Awadia Gareeballah et al[12], who also found that diabetes and hypertension were the most common causes of renal parenchymal diseases They found that hypertension was the most common finding (68%) in the study sample and this was attributed to the renal parenchymal diseases.

In our study, majority patients diagnosed with CKD (total 69 patients) had ESKD and hence a small kidney size, and a few cases with early stage of CKD (total 15 patients) with normal kidney size. So, we concluded that, patients with ESKD may have bilateral shrunken kidneys, but at early stages of CKD the kidney length may be within the normal limits.

We observed a strong correlation between renal length and advancing CKD, comparable to the findings by Emamian et al[13], who reported a positive correlation between renal length and creatinine clearance.

On the basis of Platt JF[14] reports, 0.70 is believed to be a reasonable upper limit for a normal intrarenal RI .

CONCLUSION

USG plays a great role in evaluation of patients with renal failure because of its cost-effectiveness, no radiation exposure, easy availability and reliability. We can categorize various features of gray scale USG in patients with acute renal failure and chronic kidney disease. Duplex color doppler plays a major role as it can detect damage to renal parenchymal vascular resistance. USG also has an utmost importance in follow up for grading progression or treatment response.

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