Section: Radiology

Original Research Article

ASSESSMENT OF CLINICAL UTILITY OF GRAY SCALE RENAL ULTRASOUND IN ACUTE KIDNEY INJURY

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Abstract

Background: To assess clinical utility of gray scale renal ultrasound in acute kidney injury. **Materials and Methods:** One hundred ten acute kidney injury (AKI) patients of both genders were divided into 2 groups. Group I had AKI patients and group II had healthy subjects. Parameters such as etiologies of AKI, the highest serum creatinine levels in AKI, and serum creatinine levels after therapy were collected. Renal ultrasonography (US) was performed with an Evolution E10 scanner using a 3.5–5.0 MHz wide-frequency band. The US was assessed for kidney size (the length, width, and thickness of each kidney), the thickness of the renal parenchyma, parenchymal echogenicity, RRI, and other abnormalities. **Result:** The mean serum creatinine in group I and group II was 314.5 µmol/L and 86.2 µmol/L. Length of left kidney was 108.2 mm and 105.3 mm, width of left kidney was 57.4 mm and 50.1 mm, thickness of left kidney was 47.6 mm and 40.2 mm, volume of left kidney was 145.3 cm3 and 114.7 cm3, thickness of left parenchyma was 16.9 and 16.1 respectively. Length of right kidney was 107.5 mm and 102.9 mm, width of right kidney was 56.2 mm and 48.0 mm, thickness of right kidney was 46.5 mm and 43.2 mm, volume of right kidney was 142.6 cm3and 109.8 cm3 and thickness of right parenchyma was 15.8 and 15.1 respectively. Etiology of AKI was heart failure in 20 patients, volume depletion in 24, glomerular diseases in 35, ATN in 6, sepsis in 5, obstructive nephropathy in 4, oncolytic syndrome in 3, acute leukemia in 5, severe pancreatitis in 4, and CKD with drug induced renal damage in 4. The difference was significant (P< 0.05). **Conclusion:** Gray scale ultrasound found to be effective in assessment of cases of acute kidney injury.

INTRODUCTION

Acute kidney injury (AKI) is defined by a rapid increase in serum creatinine, decrease in urine output, or both. AKI occurs in approximately 10–15% of patients admitted to hospital, while its incidence in intensive care has been reported in more than 50% of patients. Kidney dysfunction or damage can occur over a longer period or follow AKI in a continuum with acute and chronic kidney disease. Acute kidney injury (AKI) is common among hospitalized patients with a reported prevalence of 2 to 35%. The presence of AKI is associated with worse hospital outcome, and even a modest increase in creatinine significantly increases mortality.[1]

The prerenal form of AKI is because of any cause of reduced blood flow to the kidney. This may be part of systemic hypoperfusion resulting from hypovolemia or hypotension, or maybe due to selective hypoperfusion to the kidneys, such as those resulting from renal artery stenosis and aortic dissection. However, tubular and glomerular function tends to stay normal.

The renal cortex, medulla, and collecting system have different acoustic characteristics and can be easily discerned by ultrasonography (US). US is particularly useful for the evaluation of kidney diseases. Previous studies have indicated that renal histopathological changes were correlated and sonographic findings.[2] Computed X-ray tomography (CT) has higher sensitivity than US in the detection of neoplasms, stones, and calcifications. Meanwhile, magnetic resonance imaging (MRI) holds the unique advantage of being able to provide better visualization of the blood vessels. However, neither CT nor MRI have any proven advantages over US in the evaluation of kidney failure.[3]

US does not use ionizing radiation and is non-invasive, meaning that it does not require any penetration of the skin. In both acute care and ambulatory settings, US imaging can reveal information on kidney morphology, physical

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features, function, and probable anomalies.[4] US is used as the first-line imaging modality for previously undiagnosed native and transplanted, abnormal kidney function. Point-of-care US has become more accessible and widespread with increasingly portable, even handheld, US equipment.[5] To successfully use US as an adjunct to clinical decision making, a thorough understanding of the technology and its variants is required, particularly in the context of chronic kidney disease (CKD).[6] We performed this study to assess clinical utility of gray scale renal ultrasound in acute kidney injury.

MATERIALS AND METHODS

After considering the utility of the study and obtaining approval from ethical review committee, we selected one hundred ten acute kidney injury (AKI) patients of both genders. Patients' consent was obtained before starting the study.

Data such as name, age, gender etc. was recorded. Two groups were formed. Group I had AKI patients and group II had healthy subjects. Parameters such as etiologies of AKI, the highest serum creatinine levels in AKI, and serum creatinine levels after therapy were collected. Renal ultrasonography (US) was performed with an Evolution E10 scanner using a 3.5–5.0 MHz wide-frequency band. The US was assessed for kidney size (the length, width, and thickness of each kidney), the thickness of the renal parenchyma, parenchymal echogenicity, RRI, and other abnormalities (including calculus, nodules, cysts, stones, urinary retention, and hydronephrosis). Hepatic echogenicity was also recorded if present. The results were compiled and subjected for statistical analysis using Mann Whitney U test. P value less than 0.05 was set significant.

RESULTS

Group I had 60 males and 50 females and group II had 55 males and 55 females [Table 1].

Table 1: Patients distribution

Groups	Group I	Group II
Status	AKI	Control
M:F	60:50	55:55

Table 2: Comparison of parameters

Parameters	Group I	Group II	P value
Serum creatinine (µmol/L)	314.5	86.2	0.01
Length of left kidney (mm)	108.2	105.3	0.05
Width of left kidney (mm)	57.4	50.1	0.03
Thickness of left kidney (mm)	47.6	40.2	0.04
Volume of left kidney (cm3)	145.3	114.7	0.01
Thickness of left parenchyma	16.9	16.1	0.92
Length of right kidney (mm)	107.5	102.9	0.05
Width of right kidney (mm)	56.2	48.0	0.02
Thickness of right kidney (mm)	46.5	43.2	0.04
Volume of right kidney (cm3)	142.6	109.8	0.01
Thickness of right parenchyma	15.8	15.1	0.05

The mean serum creatinine in group I and group II was 314.5 µmol/L and 86.2 µmol/L. Length of left kidney was 108.2 mm and 105.3 mm, width of left kidney was 57.4 mm and 50.1 mm, thickness of left kidney was 47.6 mm and 40.2 mm, volume of left kidney was 145.3 cm^3 and 114.7 cm^3, thickness of left parenchyma was 16.9 and 16.1 respectively. Length of right kidney was 107.5 mm and 102.9 mm, width of right kidney was 56.2 mm and 48.0 mm, thickness of right kidney was 46.5 mm and 43.2 mm, volume of right kidney was 142.6 $cm^3$and 109.8 cm^3 and thickness of right parenchyma was 15.8 and 15.1 respectively. The difference was significant (P< 0.05) [Table 2].

Table 3: Etiology of AKI

Etiology	Number	P value
Heart failure	20	0.01
Volume depletion	24	
Glomerular diseases	35	
ATN	6	
Sepsis	5	
Obstructive nephropathy	4	
Oncolytic syndrome	3	
Acute leukemia	5	
Severe pancreatitis	4	
CKD with drug induced renal damage	4	

Etiology of AKI was heart failure in 20 patients, volume depletion in 24, glomerular diseases in 35, ATN in 6, sepsis in 5, obstructive nephropathy in 4, oncolytic syndrome in 3, acute leukemia in 5, severe

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pancreatitis in 4, and CKD with drug induced renal damage in 4. The difference was significant (P< 0.05) [Table 3].

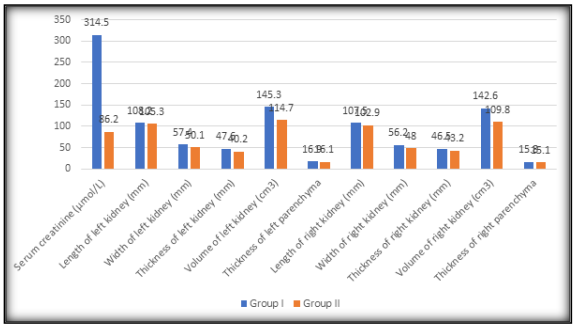

Figure 1: Comparison of parameters

DISCUSSION

AKI is very commonly seen in patients admitted to the hospital. In the United States, 1% of all hospital admissions have AKI on admission.[7] It is often an important factor in making the decision to hospitalize for other conditions, if not being the sole reason for hospitalization. During hospitalization, the approximate incidence rate of acute kidney injury is 2% to 5% and it develops in up to 67% of patients admitted in the intensive care unit.[8] Ultrasound (US) imaging is a critical diagnostic tool for assessing human kidneys. A US transducer works by transmitting radiofrequency sound waves into the body.[9] These waves interact with tissues and tissue interfaces, changing them and returning them to the transducer as echoes.[10,11] Its piezoelectric crystals vibrate in response, converting the echoes into electrical signals, which are then processed using complex algorithms to provide cross-sectional images of the body's underlying tissue layers.[12,13] We performed this study to assess clinical utility of gray scale renal ultrasound in acute kidney injury.

Our results showed that group I had 60 males and 50 females and group II had 55 males and 55 females. Liu et al,[14] determined ultrasonography (US) in patients with acute kidney injury (AKI) and the association of US findings with its clinical characteristics. A healthy control group was matched by sex and age at a ratio of 2:1 with the AKI group. The US characteristics were compared between the two groups. The US characteristics of 111 patients with AKI were evaluated. Compared with the control group, AKI patients had greater kidney length and kidney volume (P<0.05). Patients with AKI also displayed thicker parenchyma than those in the control group, but only the difference in the right kidney was found to be significant. Of the 111 AKI patients, 38 had positive US findings including increased parenchymal echogenicity, increased renal resistance index (RRI), and hydronephrosis, while only 5 patients had increased RRI. The cause of AKI was attributed to obstructive nephropathy in eight patients.

Our results showed that the mean serum creatinine in group I and group II was 314.5 µmol/L and 86.2 µmol/L. Length of left kidney was 108.2 mm and 105.3 mm, width of left kidney was 57.4 mm and 50.1 mm, thickness of left kidney was 47.6 mm and 40.2 mm, volume of left kidney was 145.3 cm^3 and 114.7 cm^3, thickness of left parenchyma was 16.9 and 16.1 respectively. Length of right kidney was 107.5 mm and 102.9 mm, width of right kidney was 56.2 mm and 48.0 mm, thickness of right kidney was 46.5 mm and 43.2 mm, volume of right kidney was 142.6 cm3and 109.8 cm^3 and thickness of right parenchyma was 15.8 and 15.1 respectively. Podoll et al15 studied all patients who underwent a RUS were identified over the three-year period. AKI was defined as a 50% increase in baseline creatinine or a urine output of less than 0.5 ml/kg/hr for more than 12 hours. To determine the cause of AKI the presence of contributing factors such as sepsis, hypotension, recent surgery, decompensated heart failure, volume overload, use of intravenous radiocontrast media, and use of nephrotoxic medications were recorded. Diagnoses predisposing to urinary tract obstruction were ascertained for each patient from review of the medical record. Prior abdominal or pelvic malignancy, benign prostatic hypertrophy, nephrolithiasis, ectopic pregnancy, pelvic inflammatory disease, prior pelvic surgery, neurogenic bladder, anatomic genitourinary abnormality, abdominal trauma, and prior renal surgery were considered risk factors for urinary tract obstruction. In their study 1471 renal ultrasounds were performed of which 55% (810) were for evaluation of acute kidney injury. Renal ultrasound was normal in 62% (500 of 810) of patients. Hydronephrosis was detected in only 5% (42 of 810) of studies and in only 2.3% (19 of 810) of the cases was obstructive uropathy considered the cause of acute kidney injury. The majority of these patients (14 of 19) had a medical history suggestive of urinary tract obstruction. Less than 1% of patients (5 of 810) had urinary tract obstruction on ultrasound without a suggestive medical history. Most other ultrasound findings were incidental and did not establish an etiology for the acute kidney injury.

Etiology of AKI was heart failure in 20 patients, volume depletion in 24, glomerular diseases in 35, ATN in 6, sepsis in 5, obstructive nephropathy in 4, oncolytic syndrome in 3, acute leukemia in 5, severe pancreatitis in 4, and CKD with drug induced renal damage in 4. In Mounier- Vehier et al,[14] study, the kidneys of 49 patients with hypertension were assessed by spiral CT. Although the size of the kidneys was still within the normal range, the thickness of the cortex after renal artery stenosis was reduced.

Moghazi et al,[15] assessed the correlation between ultrasound parameters and histopathological changes of glomerulosclerosis, renal tubular atrophy, interstitial fibrosis, and interstitial inflammation in 207 patients. Renal tubular atrophy

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and interstitial inflammation, rather than interstitial fibrosis, are considered as factors for determining cortical histopathological changes. This is because the glomerulus accounts for only 8% of cortical volume, and increased parenchymal echogenicity does not necessarily change in glomerular diseases. On other hand, Keyserling et al,[16] found that of 100 renal ultrasounds performed for AKI in patients without clinical findings suggestive of obstruction, only one case of hydronephrosis was found.

CONCLUSION

Gray scale ultrasound found to be effective in assessment of cases of acute kidney injury.

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