Original Article

Estimation of renal failure in hemodialysis patients using ultrasound

Mwahib Aldosh[1], Rania Mohammed Ahmed[2]*, Nahla L. Faizo[2], Ahmad Joman Alghamdi[2], Wisal B Hassan[2], Nagwan Elhussein[3], Meaad Elbashir[4]

[1]Department of Radiological Sciences, Applied Medical College, Najran University, KSA. [2]Department of Radiological Sciences, College of Applied Medical Sciences, Taif University, KSA. [3]Department of Diagnostic Radiology, College of Applied Medical Sciences, University of Hail, Saudi Arabia. [4]Department of Diagnostic Radiography Techhnology, College of Applied Medical Sciences, University of Jazan, KSA.

Correspondence: Rania Mohammed Ahmed, Department of Radiological Sciences, College of Applied Medical Sciences, Taif University, KSA. rania_awad1@hotmail.com

ABSTRACT

This study aims to emphasize the value of the ultrasound technique in estimating and evaluating characterization features of renal failure among Sudanese patients to increase public awareness of renal failure and its consequences. Material and Ninety-six Sudanese hemodialysis participants were diagnosed having renal failure disease and being evaluated from April to Sep 2020, and followed up by Ultrasound. The inclusion criteria were retrieved and patients having other renal pathologies or patients less than 20 years old were excluded. Gender distribution revealed that males were being affected slightly more than females (52.1%), with a male: female ratio of (1.1). The age group (20-30) years had the higher prevalence with (24 %). (65.6%) of the obtained sample were married. Clinical etiology achieved that (42.7%) had hypertension followed by (33.3%) had diabetes. (83.3%) had chronic end-stage renal failure. Regarding sonographic estimations; (55.2%) had normal kidney size, outline, and parenchymal echogenicity during an ultrasound, while (51%) had increased parenchymal echogenicity and (57.3%) had poor corticomedullary differentiation. The study proved that ultrasound is accurate in detecting and estimating the characterization of renal failure. Also, the study emphasizes the importance of regular follow-up of patients in hemodialysis by ultrasound technique to assess their condition and improve the way of treatment.

Keywords: Gender, Renal failure, Hemodialysis, Sudanese, Ultrasound

Introduction

Renal failure is a global health concern, and in both high and medium-income countries, end-stage renal failure (ESRD) has recently increased. Renal failure is considered when the degree of kidney function is less than 15 percent, or when the rate of glomerular filtration is less than 15 ml/minute per 1.73 m2 and the kidneys do not extract or monitor metabolic end products from the blood as a result. The treatment of choice for kidney failure is renal transplantation, but it is not always feasible. Hemodialysis is one of the treatment choices for renal failure since small molecular waste products such as creatinine or uric acid are removed and extracellular fluid equilibrium is maintained [1]. Hemodialysis patients have higher mortality rates than the general population and recent concerns about the possible consequences of dialysis have been resolved [2]. These issues have been supported by several studies [3, 4]. It showed that early dialysis is better for renal function and would improve the outcome of the disease with the contribution of more times per week of dialysis and regular follow-up with imaging techniques such as ultrasonography.

In Sudan, due to the drastic increase in the number of cases of renal failure, especially those with ESRD treated with regular

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Aldosh M, Ahmed RM, Faizo NL, Alghamdi AJ, Hassan WB, Elhussein N, et al. Estimation of renal failure in hemodialysis patients using ultrasound. J Adv Pharm Educ Res. 2021;11(2):146-50. https://doi.org/10.51847/NNT1u67AoT

hemodialysis, more concern has recently emerged. The combination of high population growth and lifestyle changes may be the reason for increasing the prevalence of the current status [5]. Early diagnosis of patients with renal failure has been documented in several studies to dramatically reduce morbidity and mortality and to provide appropriate early intervention to prevent unnecessary complications [6]. So, this study aims to characterize and estimate renal failure to find out new aspects which may be valuable for improving public health and to assist healthcare professionals in the area of the research [7, 8].

Kidney injury, such as renal hypertension, diabetes, obstruction, infection, malignancy, deformity, toxicity, or decreased blood flow to the kidneys, can lead to a wide range of disorders or conditions. Besides creatinine levels and radiology imaging tests, renal failure is typically diagnosed by clinical history.

Medical ultrasound is a diagnostic imaging procedure used to vis ualize internal abdominal organs such as kidneys, liver,
and spleen. As contrast material is not required, it remains the i maging modality of choice in assessing renal failure.

Ultrasound is a real-time imaging tool that is useful for reliably determining the morphological appearance of the kidneys. It is also ideal for detecting any pathological conditions such as kidney stones, tumors, glomerulonephritis, ureteral or urethral obstruction [9].

Cortical echogenicity may only be assessed qualitatively, and it should be lower than that of the liver or the spleen. The medulla should be less echogenic than the cortex, but this is contingent on scanning conditions and overlaying structures to be discerned. Although ultrasonography studies typically highlight a lack of cortico-medullary distinction, the inability to see the medullae is common and not pathological. Instead, medullae prominence is commonly aberrant, showing greater echogenicity of the cortex [10]. It is important to consider the functions of instrument techniques not only for the diagnosis and management of kidney disorders but also as a reference for other invasive radiological procedures when estimating the nephrology characterizations by US technology. Therefore, the characterization of renal failure, which may occur as an acute or chronic occurrence, must be assessed.

Acute renal failure (ARF) is characterized as renal function damage and disability that typically occurs unexpectedly over days due to renal conditions such as acute pyelonephritis, obstruction of the urinary tract, shock, or toxicity. Chronic kidney disease (CKD) refers to a disorder in which the kidneys are weakened and renal function deteriorates over a long time (months to years), typically caused by long-term illnesses such as diabetes and high blood pressure [11].

This study aims to characterize and evaluate renal failure in Sudanese patients undergoing hemodialysis who have been scanned periodically with ultrasound to assess the major factors that influence the status. Outcomes from this study would help improve the management of renal failure disease and increase awareness toward renal failure and its influences among the community.

Materials and Methods

Problem of the study

Increased prevalence of renal failure particularly end-stage renal failure among the Sudanese population.

Inclusion and exclusion criteria

The database registry was limited to hospitalized Sudanese hemodialysis patients who were diagnosed having renal failure using ultrasound scanning in the period from Jan to April 2020 with ages 20 years old and above were included in this study. The exclusion is limited to normal conditions or other renal pathologies and patients less than 20 years old.

Type, date, and place of the study

This is a prospective descriptive study conducted at hemodialysis center in the teaching hospital at Khartoum city, Sudan, in the period from April to Sep 2020. US investigations were requested by nephrologists and the ultrasound reports were diagnosed and signed by expert radiologists.

Method

Well-structured checklist was used to collect the data from patients' medical records and ultrasound images reports; Ultrasound variables were reported including kidney size, shape or outlines parenchymal echogenicity, corticomedullary differentiation, and other signs detected during an ultrasound scan.

Statistical analysis

The software Statistical Package for Social Sciences (SPSS) version 21.0 was used to analyze the data. Pearson's correlation test was used for statistical analysis of ultrasound findings and renal classification. The statistical association was considered to be significant when $P < 0.05$.

Ethical considerations

Confidential consent and authorship requirements have been met in this study. Regarding financial considerations. The authors declare no conflict of interest.

Results and Discussion

Characterizations of renal failure using ultrasound estimations were taken including morphology, type, kidney size, parenchymal echogenicity, corticomedullary differentiation, and other shreds of evidence detected by the scan. The study included 96 hemodialysis Sudanese patients who were diagnosed with renal failure disease using Ultrasound techniques. They were classified into two groups, the first

group was acute renal failure (ARF) and the second group was chronic renal failure (CRF). First, the demographic information including age groups between (20-90 years), gender distribution, marital status, and medical history was analyzed in the study. Then, the outcomes of sonographic estimations measures of renal failure characterizations were examined.

Regarding gender distribution, males were slightly more affected than females with (52.1%) & (47.9%) consecutively.

Table 1. Age groups distribution among the study sample

Age groups	Freq	%	Cumulative %
20-30	23	24.0	24.0
31- 40	16	16.7	40.6
41-50	8	8.3	49.0
51- 60	15	15.6	64.6
61-70	13	13.5	78.1
71- 80	11	11.5	89.6
81- 90	10	10.4	100.0
Total	96	100.0	

Table 2. Marital status * Renal failure classification correlation

Marital status	Acute renal failure (ARF)	Chronic renal failure	%	Exact Sig. (2-sided)
Single	16	17	33	
Married	0	63	63	.000
Total	16	80	100	

Most patients were married (65%) and significant correlations were found between marital status and the type of renal failure (p value=0.00)

Table 3. Disease profiles among the study sample.

Clinical finding	Freq	%	Cumulative Percent
Diabetes	32	33.3	33.3
Glomerular disease	7	7.3	40.6
Genetic Factors	3	3.1	43.8
Hypertension	41	42.7	86.5
Polycystic kidney	3	3.1	89.6
Obstruction	6	6.3	95.8
Unknown	4	4.2	100.0
Total	96	100.0	

Regarding clinical etiologies of renal failure, hypertension was found to have the highest percentage (41%) followed by diabetes in 33.3% of patients, whereas the least cause was related to genetic factors (3%) as shown in **Table 5** below.

Table 4. Demonstrate Ultrasound estimation for kidney size

Kidney size	Freq	%	Cumulative %
Normal	53	55.2	55.2
Large	14	14.6	69.8
Small	29	30.2	100.0
Total	96	100.0	

Table 5. Demonstrate Ultrasound estimation of renal parenchymal echogenicity

Parenchymal echogenicity	Freq	%	Cumulative %
Normal	28	29.2	29.2
Increased	49	51.0	80.2
Decreased	19	19.8	100.0
Total	96	100.0	

Table 6. Ultrasound Estimation for Corticomedullary differentiation

	Freq	%	Cumulative %
Good	41	42.7	42.7
Poor	55	57.3	100.0
Total	96	100.0	

Table 7. Demonstrate the correlation of sonographic characterizations values and renal failure classification

Correlation		Kidney size	Parenchymal echogenicity	Corticomedullary differentiation	Renal failure classification
Kidney size measure during ultrasound scan	Pearson Correlation	1	.756**	.728**	.377**
	Sig. (1-tailed)		.000	.000	.000
	N	96	96	96	96
Parenchymal echogenicity	Pearson Correlation	.756**	1	.734**	.584**
	Sig. (1-tailed)	.000		.000	.000
	N	96	96	96	96
Corticomedullary differentiation	Pearson Correlation	.728**	.734**	1	.518**
	Sig. (1-tailed)	.000	.000		.000
	N	96	96	96	96
Renal failure classification	Pearson Correlation	.377**	.584**	.518**	1
	Sig. (1-tailed)	.000	.000	.000	
	N	96	96	96	96

*There was sig correlation between the variables represented as (p= 0.000)

US findings regarding morphological structures seen in renal failure including kidney size, parenchymal echogenicity, and corticomedullary differentiation revealed that most of the conditions have normal kidney size with a percentage of 55.2%, mean 1.75 and 51.0 percent achieved for increased parenchymal echogenicity with mean value 1.91.Most of the conditions appeared with poor corticomedullary with percentage of 57.3 and mean of 1.57.

This study aimed to evaluate the measures of ultrasound to characterize features of renal failure in Sudanese patients.

The use of ultrasound examinations has significantly increased nowadays, due to the affordability and protection of its use. Furthermore, it is a non-ionizing, non-invasive procedure that

needs no contrast content, which can increase the issue, particularly when renal failure is examined. The most diagnostic tools used for assessing patients with renal failure are ultrasound since it helps estimate and detect the size, position, and shape of the kidneys. It also assesses the features associated with morphological presentation, disease severity, and further renal failure abnormalities [4, 12].

Chronic renal failure is a common disease in Sudan [6, 13]. In this study, 96 patients had high serum creatinine levels who have been diagnosed with renal failure, (87.8%) of them have had chronic renal failure, and all of them were married, as in **Table 2**. All the patients in this study were investigated by the US, which was performed before and after hemodialysis therapy. Regarding demographic prevalence among the study sample in this study, males were more affected than females with (52.1% & 47.9%) consequently. Age group (20-30) years have had the higher percentage of (24%), as in **Table 1**. These results are in line with several previous studies [6, 13, 14]. In this study, it was found that most patients were married (65.6%) as shown in **Table 2**.

In particular, in patients undergoing hemodialysis, marital status is a significant social factor associated with mortality from renal failure. However, as documented in one previous study, unmarried or single patients have been associated with an increased risk of depression and unhealthy behaviors. Although similar results were demonstrated in previous study [2], but this issue is still controversial, because it depends on local cultural factors.

Acute or chronic renal failure may result from a broad range of clinical conditions, including renal hypertension, diabetes, glomerulonephritis, obstruction, infection, malignancy, deformity, toxic ingestion, or decreased blood supply to the kidneys. The chronic renal failure form was most commonly diagnosed by ultrasound in the current study. This result match results from previous studies [12, 15], where most patients are diagnosed with hypertension 45%, followed by diabetes in 29%, as in **Table 3**. These findings were also reported on other previous studies [16, 17], and also confirmed that diabetes, hypertension, and glomerulonephritis were the main causes of chronic renal failure.

Regarding estimation of the morphological appearance during an ultrasound scan, this study showed different estimations of kidney texture and size. Normal kidney size was represented in 55.2% from the study sample, whereas small kidney size was shown in 30.2% and large kidney size was detected in 14.6%, as in **Tables 4, 5 and 6**. This finding is similar to results from previous studies which have reported that kidney size in patients with renal failure was much smaller than the normal one [10, 17].

Ultrasound measure of parenchymal echogenicity revealed that 51% of patients have an increased parenchymal echogenicity with a mean value (1.91); most of them appeared with poor corticomedullary with the percentage of 57.3% and mean of (1.57) while 42.7% were achieved normal texture during an ultrasound with significant correlation between characterizations of US values and renal failure classification, as in **Table 7**. Many previous studies proved that ultrasound provides accurate estimating measures of renal abnormalities. However, early detection and accurate diagnosis are critical to slowing the progression of chronic kidney disease (CKD) were being reported in National Kidney Foundation (NKF) [18].

[19-21]. These variations may be attributed to multiple medical causes or may be due to geographical differences and regional effects. In this study, the geographical region may affect the obtained estimations results, because the study is a single-center that included participants from one region.

Conclusion

This study proved that ultrasound is a critical component for the evaluation of renal failure. The ease visualization of the kidneys, safety, and low cost of sonography, make it the modality of choice for renal imaging, and it can differentiate between acute and chronic renal failure. This research emphasizes the need to increase and promote awareness toward patients suffering hemodialysis.

Acknowledgments: Ethical approval was obtained verbally from hemodialysis centers in Khartoum teaching hospital at Khartoum city, Sudan by Dr. Mwahib Aldosh. All authors would like to thank all medical team of the centrs for their collaboration and assistance in conducting this research.

Conflict of interest: None

Financial support: None

Ethics statement: None

References

1. Centers for Disease Control and Prevention. Chronic kidney disease surveillance system website. Available from: http://www.cdc.gov/ckd Accessed September 2018.
2. Tanno K, Ohsawa M, Itai K, Kato K, Turin TC, Onoda T, et al. Associations of marital status with mortality from all causes and mortality from cardiovascular disease in Japanese haemodialysis patients. Nephrol Dial Transplant. 2013;28(4):1013-20.
3. Ziemba R, Campbell KN, Yang TH, Schaeffer SE, Mayo KM, McGann P, et al. Excess Death Estimates in Patients with End-Stage Renal Disease—United States, February–August 2020. Morb Mortal Wkly Rep. 2021;70(22):825-9.
4. Odutayo A, Wong CX, Farkouh M, Altman DG, Hopewell S, Emdin CA, et al. AKI and long-term risk for cardiovascular events and mortality. J Am Soc Nephrol. 2017;28(1):377-87.

5. Gameraddin M, Ismeal M, Yousef M, Tamboul J, Salih S. The Sonographic Estimation of Renal Length and Determination of the Main Causes of Chronic Renal Failure. Life Sci J. 2014;11(5):222-5.
6. Suliman SM, Beliela MH, Hamza H. Dialysis and Transplantation in Sudan. Saudi J Kidney Dis Transpl. 1995;6(3):312-4.
7. Ren-Zhang L, Chee-Lan L, Hui-Yin Y. The awareness and perception on Antimicrobial Stewardship among healthcare professionals in a tertiary teaching hospital Malaysia. Arch Pharm Pract. 2020;11(2):50-9.
8. Hanawi SA, Saat NZ, Zulkafly M, Hazlenah H, Taibukahn NH, Yoganathan D, et al. Impact of a Healthy Lifestyle on the Psychological Well-being of University Students. Int J Pharma Res Allied Sci. 2020;9(2):1-7.
9. Germain MJ, Tamura MK, Davison SN. Palliative care in CKD: the earlier the better. Am J Kidney Dis. 2011;57(3):378-80.
10. O'Neill WC. Renal relevant radiology: use of ultrasound in kidney disease and nephrology procedures. Clin J Am Soc Nephrol. 2014;9(2):373-81.
11. Aldrich JE. Basic physics of ultrasound imaging. Crit Care Med. 2007;35(5):S131-7.
12. Hull TD, Agarwal A, Hoyt K. New ultrasound techniques promise further advances in AKI and CKD. J Am Soc Nephrol. 2017;28(12):3452-60.
13. Banaga AS, Mohammed EB, Siddig RM, Salama DE, Elbashir SB, Khojali MO, et al. Causes of end stage renal failure among haemodialysis patients in Khartoum State/Sudan. BMC Res Notes. 2015;29(9);8:502.
14. Gameraddin M, Ismeal M, Yousef M, Tamboul J, Salih S. The sonographic estimation of renal length and determination of the main causes of chronic renal failure. Life Sci J. 2014;11(5):222-5.
15. Gaitonde DY, Cook DL, Rivera IM. Chronic kidney disease: detection and evaluation. Am Fam Physician. 2017;96(12):776-83.
16. Mansour AA, Gasmalseed H, Eltahir MA, Osman ME. Renal Changes in Length and Parenchymal Thickness in Diabetic and Hypertensive Patients with Normal eGFR & Serum Creatinine Using Ultrasonography. Int J Collab Res Intern Med Public Health. 2020;12(1):965-71.
17. Lamarche J, Rivera AP, Courville C, Taha M, Antar-Shultz M, Reyes A. Role of Point-of-Care Ultrasonography in the Evaluation and Management of Kidney Disease. Fed Pract. 2018;35(12):27-33.
18. The facts about chronic kidney disease. National Kidney Foundation website. Available from: www.kidney.org/atoz/content/about-chronic-kidney-disease#facts.Accessed July 2019.
19. Elsharif ME, Elsharif EG. Causes of end-stage renal disease in Sudan: a single-center experience. Saudi J Kidney Dis Transpl. 2011;22(2):373-6.
20. Annual Report. Saudi Center for Organ Transplantation. (Updated: 2018, Accessed 2018 September). Available from: URL: http://www.scot.org.sa.
21. Collins AJ, Foley RN, Chavers B, Gilbertson D, Herzog C, Ishani A, et al. US Renal Data System 2013 Annual Data Report. Am J Kidney Dis. 2014;63(1):471-6.