Original Article

Echocardiographic Findings in Chronic Kidney Illness Patients, Both on Hemodialysis and those not Receiving Hemodialysis, at Al-Diwaniyah Teaching Hospital

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Abstract

Background: Chronic kidney disease (CKD) is a major public health problem worldwide with increased incidence and prevalence. It is defined as irreversible deterioration of renal function for more than 3 months by structural or functional abnormalities resulting in impairment of excretory, metabolic, and endocrine functions, leading to a clinical syndrome of uremia. Cardiovascular disease is the main cause of mortality and morbidity in chronic kidney patients; it is about 10- to 30-fold more than in the general population. Most patients succumb to cardiac disease before reaching end-stage, so there should be a focus on the prevention of cardiovascular complications in the early stages. **Objectives:** To study various cardiovascular changes in chronic kidney patients on hemodialysis and on non-hemodialysis with the help of two-dimensional echocardiography. **Materials and Methods:** A cross-sectional study was conducted during the period from March 12 to July 10, 2023, at Al-Zahraa Dialysis Center in Al-Diwaniyah teaching hospital. The study included 124 patients (64 dialysis group and 60 nondialysis group). A history and examination were performed for every patient, including measuring left ventricular systolic dysfunction, left ventricular diastolic dysfunction, left ventricular wall thickness, valves, and ejection friction, and data was analyzed using SPSS version 26. **Results:** The mean age and body mass index were significantly higher among the dialysis group. The family history of CKD, diabetes mellitus, and smoking history were risk factors a more significant in dialysis group than nondialysis; left ventricular hypertrophy (LVH) and valvular disease were more significant in dialysis group. Only 70% of patients in the nondialysis group had abnormal echo findings, whereas 81.2% of patients in the dialysis gsroup had abnormal echo findings. **Conclusion:** Only 30% of patients on nondialysis group had normal echo finding while 18.7% of patients on dialysis group had normal echo finding.

Keywords: CKD, echocardiography, hemodialysis

Introduction

Chronic kidney disease (CKD) is defined as kidney damage for more than 3 months by structural or functional abnormalities of the kidney, with or without decreased glomerular filtration rate (GFR), manifest by either pathological abnormalities or markers of the kidney damage, including abnormalities in the composition of the blood or urine, or abnormalities in an imaging test.[1] It represents a worldwide public health problem, with a global prevalence of 9.1%. It increases the risk of all-cause mortality, cardiovascular disease, and progression to end-stage renal disease (ESRD).[2] Thus, identifying the risk factors for CKD or a decrease in estimated GFR (eGFR) may help in understanding the mechanism of CKD and provide new strategies for its prevention. It is classified into five stages based on the severity of reduced kidney function as measured by the GFR and the severity of albuminuria. In young healthy adults, the normal

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GFR is approximately 125 mL/min/1.73 m^2, thus kidney disease improving global outcome is defined a GFR of less than 60 mL/min/1.73 m^2 as indicating reduced kidney function.[3]

cardio vascular disease (CVD) is the main cause of morbidity and mortality in CKD patients. A strong association exists between CKD and CVD, with an increase in CVD observed with declining GFR. In adults, signs of renal destruction may comprise albuminuria, alterations in renal imaging, hematuria/leukocyturia, persistent hydroelectrolytic illnesses, histological alterations in kidney biopsy, and prior kidney transplantation.[4] The condition known as albuminuria is characterized by the detection of over 30 mg of albumin in a 24-h urine sample or more than 30 mg/g of albumin in a single urine tester attuned via urinary creatinine. The prime factors contributing to CKD encompass diabetes, hypertension, long-lasting glomerulonephritis, long-lasting pyelonephritis, prolonged usage of anti-inflammatory drugs, autoimmune disorders, polycystic kidney illness, Alport disorder, congenital malformations, and extended episodes of severe renal illness.[1]

Echocardiographic abnormalities are very common in patients suffering from ESRD, so periodic echocardiographic examination for early diagnosis and early treatment of cardiac abnormalities is highly recommended to prevent mortality examinations often reveal variations in cardiac structure and function among CKD more common in patients undergoing hemodialysis.[5] Notably, the risk of cardiovascular death in dialysis patients is 10–30 times more than in the general population. Aim of the study: To study various cardiovascular changes in long-lasting kidney disease patients on hemodialysis and non-hemodialysis with the help of two-dimensional echocardiography.

Materials and Methods

A hospital-based, cross-sectional study with analytical elements. The data collection was conducted during the period from March 12 to July 10, 2023, among the patients with CKD on hemodialysis and non-hemodialysis attending the nephrology unit (Al-Zahraa Dialysis Center) in Al-Diwaniyah teaching hospital in Al-Diwaniyah governorate. The study included 124 patients (64 dialysis group and 60 nondialysis group). A history, examination, and echocardiography were performed for every patient. Data collection was done in about 5 h per day for 5 days a week.

Inclusion criteria: The study included patients with CKD on maintenance dialysis (dialysis group) with CKD stages 4 and 5, and on medical treatment (nondialysis group) with CKD stages 1, 2, and 3 of both genders and ages from 20 to 70 years. Exclusion criteria: Patient with a history of renal transplantation, a history of coronary artery disease, valvar heart disease, pericardial effusion, rheumatic heart disease, congenital heart disease, and primary cardiomyopathy were excluded from the study. The data were collected using a self-constructed questionnaire which was established depending on information obtained from reviewing previously published articles and from consultation with family medicine and cardiologist specialists. The data were collected by direct interviews with participants. The questionnaire form was based on the following socio-demographic characteristics of patients: past medical history and biochemical investigation includes fourteen questions. Weight in kilograms and height in meters were measured for each patient to calculate body mass index (BMI) through the following equation: BMI = kg/m^2. BMI is categorized to underweight if BMI is fewer than 18.5, normal if BMI is from 18.5 to 24.9, overweight if BMI is from 25 to 29.9, and obese if BMI is 30 and above. A 12-lead high-resolution electrocardiography (ECG), which was recorded at a speed of 25 mm/s and a voltage of 10 mm/mV, was obtained from all patients after a 10-min rest. Patients were allowed to breathe freely but not to speak or cough during recordings. All ECG papers were scanned by two independent cardiologists blinded to other patients' clinical information, for signs of hyperkalemia, including peaking of *T* waves, QRS prolongation (QRS is ventricular contraction systole consist of Q wave is first negative deviation, R wave is positive deviation and S wave is negative deviation), and PR (PR interval is time between atrial depolarization and ventricular depolarization) shortening.

A 2D echocardiography was done by two independent cardiologists using a Vivid S5 echocardiography machine equipped with a 3-MHz probe. The left side location was adopted for echocardiographic assessment in CKD sick. Detailed echocardiographic examinations were performed, including the next visions: (1) Left parasternal extended axis; (2) left parasternal short axis; and (3) apical: 4 chambers, 5 chambers (for aortic valve flow), 2 chambers, and 3 chambers. M-mode was used to assess cardiac fundamental and purposeful parameters. Patients with left ventricular expulsion fraction (EF) below 50% were analyzed with left ventricular dysfunction. For determining left ventricular diastolic dysfunction, the E/A proportion stayed designed by means of Doppler velocity measurements, and an E/A proportion below 0.75 or above 1.8 indicated LV diastolic dysfunction. Additionally, sick with an intra-ventricular width or LV posterior wall width greater than or equal to 12 mm were diagnosed with left ventricular hypertrophy (LVH). Approvals were gained from the ethical consideration in the Department of Family and Community Medicine in Al-Qadisiyah College of Medicine and formal agreement was obtained from Al-Diwaniyah health directorate, this formal is representative of Iraqi Ministry of Health. The purpose of the study was explained to the participant to

get their verbal consent. The data were analyzed using the statistical set for the social sciences (SPSS version 26) computer software program after being derived from each patient and transferred into a data sheet of Microsoft Excel software of Windows Descriptive statistics existing as frequency tables, continuous variables stayed articulated as mean ± standard deviation and categorical variables as numbers and percentages. Analytics statistics as Chi-square test to invention association among two categorical variables. The *P* value below or equal to 0.05 was considered to be statistically significant. Limitation of the study: The study was hospital-based in CKD patients; hence, the results do not represent the whole population. Small sample size due to limited time.

Ethical approval

The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. It was carried out with patients verbal and analytical approval before the sample was taken. The study protocol and the subject information and consent form were reviewed and approved by a local ethics committee according to the document number (including number 13 and the date of March 5, 2023) to get this approval.

Result

1 The demographic characteristics of patients included in this study are presented in Table 1. There was a significant difference in the average age among the nondialysis and the dialysis grouping ($P < 0.001$). Similarly, there was a significant difference in average BMI among the nondialysis and the dialysis grouping ($P < 0.001$), in addition to significant variation in the frequency distribution of patients based on BMI interval ($P < 0.001$). Nevertheless, there was no significant difference in the frequency distribution according to gender between the nondialysis and the dialysis grouping ($P = 0.151$).
2 Comparison of rates of history of chronic medical illnesses between the study group is exposed in Table 2. There was a significant difference in the frequency distribution saccording to family history CKD among nondialysis and dialysis grouping ($P = 0.004$). There was

Table 1: Demographic characteristics of patients included in this study

Characteristic	Nondialysis grouping, $n = 60$	Dialysis grouping, $n = 64$	*P*
Age (years)			
Mean + SD	45 ± 14.91	56.47 ± 15.15	<0.001 I
Range	20–70	21–70	
BMI (kg/m^2)			
Mean + SD	25.65 ± 4.25	27.21 ± 3.10	0.021 I
Range	18.67–38.57	20.81–36.72	
Normal weight	12 (20.0%)	34 (53.1%)	<0.001 C ***
Overweight	44 (73.3%)	18 (28.1%)	
Obese	4 (6.7%)	12 (18.8%)	
Gender			
Male	26 (43.3%)	36 (56.3%)	0.151 C NS
Female	34 (56.7%)	28 (43.8%)	

C: Chi-square test, I: independent test, NS: not significant
***Significant at $P \leq 0.001$

Table 2: Comparison of history of chronic medical illnesses between the study groups

Characteristic	Nondialysis group, $n = 60$	Dialysis group, $n = 64$	*P*
Family history of CKD			
Negative	54 (90.0%)	44 (68.8%)	0.004 C **
Positive	6 (10.0%)	20 (31.3%)	
HTN			
Negative	12 (20.0%)	14 (21.9%)	0.798 C
Positive	48 (80.0%)	50 (78.1%)	NS
DM			
Negative	28 (46.7%)	44 (68.8%)	0.013 C *
Positive	32 (53.3%)	20 (31.3%)	
Smoking			
Nonsmoker	50 (83.3%)	42 (65.6%)	0.024 C *
Smoker	10 (16.7%)	22 (34.4%)	

C: Chi-square test, CKD: chronic kidney disease, DM: diabetes mell itus, HTN: hypertension, NS: not significant
*Significant at $P \leq 0.05$
**Significant at $P \leq 0.01$

Table 3: Results of ECG findings

Characteristic	Nondialysis group, $n = 60$	Dialysis group, $n = 64$	P
ECG			
Normal	60 (100.0%)	50 (78.1%)	<0.001 C ***
Sign of hyperkalemia	0 (0.0%)	14 (21.9%)	

C: Chi-square test, ECG: electrocardiography

***Significant at $P \leq 0.001$

no significant difference in the frequency distribution according to hypertension between nondialysis and dialysis grouping ($P = 0.798$). There was a significant variance in the frequency distribution according to diabetes mellitus between nondialysis group and dialysis group ($P = 0.013$). There was a significant difference in the frequency distribution according to smoking between nondialysis and dialysis grouping ($P = 0.024$).

3 Results of electrocardiogram findings are shown in Table 3. The rate of positive ECG findings was significantly more in dialysis group than in nondialysis group ($P < 0.001$).

4 Results of echo findings are shown in Table 4. There was a significant difference in mitral regurgitation (MR), tricuspid regurgitation (TR), PR, LVH, pericardial effusion, and global hyperkinesia ($P < 0.05$), but there was no significant variance in valve aortic regurgitation (AR), left ventricular (LV) systolic dysfunction, diastolic dysfunction, and EF ($P > 0.05$).

Discussion

Echocardiography is a valuable tool to assess changes in the heart's function and structure caused by CKD.[6] Consequently, assessing echocardiographic parameters in CKD patients can help in determining the risk and prognosis of cardiovascular disease in this population.[7] In the current study, the mean age of patients in the dialysis grouping was 56.47 years, while the average age of patients in the nondialysis grouping was 45 years. This finding is consistent with a meta-analysis conducted by Hill *et al*., which examined the influence of age on CKD prevalence. The meta-analysis indicated a progressively upper occurrence of CKD phases 1–5 with advancing age, extending from 13.7% in the 30- to 40-year-old grouping to 27.9% in patients aged >70–80 years.[8] Moreover, a research conducted by Zhu *et al*. included 207 patients undergoing peritoneal dialysis, with a mean age of 52.14 ± 14.93 years,[9] as, Janjua *et al*.[10] conducted a study among 111 ESRD sick, and the average age of the participants was 55.85 years (SD ± 13.95 years).

The current study revealed that the dialysis group has a significant higher mean of males compared to the nondialysis grouping. This observation may be related to a fact reported in a meta-analysis of 30 studies, which indicated that CKD development was quicker in males compared to females.[11] Such differences in CKD progression between genders might be influenced by non-biological features, such as lifestyle, national, and socioeconomic features.[12]

The existing study designated a significant difference in mean BMI among the dialysis and nondialysis grouping, with the dialysis grouping having a higher mean BMI. This finding was in line to observational studies that have stated positive relations among obesity and ESRD. Several studies, such as the ones conducted by Mohammedi *et al*.[13] and the Vivante[14], have provided evidence that obesity acts as an independent danger feature for ESRD, both in diabetic and nondiabetic individuals.

Among patients with ESRD, 31.1% reported having a family history of CKD, a finding consistent with Song *et al*.'s study conducted in the United States[15]. In Song's study, incident dialysis patients were screened for a family history of ESRD, and close families with ESRD were identified in nearly 23% of the patients after excluding those with genetic illnesses and urologic reasons for ESRD. Therefore, it is recommended to screen high-risk family members of those with CKD to inhibit the development of the kidney disease.[16]

In the industrialized world, diabetes mellitus and hypertension have emerged as the greatest significant danger features for CKD, as indicated by studies investigating CKD incidence.

In the present study, the hypertension was analyzed in 78.1% of dialysis patients and DM was diagnosed in 31.3% of dialysis patients this is similar to the study by Adhikaree *et al*.[17] where hypertension was found among 92.2%, and diabetic mellitus was found among 37.4% of the hemodialysis group. Another study conducted by Tsilonis *et al*.[7] found that diabetes mellitus was present in 24% of CKD patients on hemodialysis, while hypertension was present in 22% of patients another study found forty-one patients (45.56%) were diabetic and 74 (82.22%) were hypertensive. The prevalence of hypertension increased from 66.67% to 89.29% as the CKD stage progressed from stage II to stage V.[18] Hypertensive nephropathy was the main cause of CKD in half of the patients, whereas type 2 diabetes mellitus was the underlying cause of ESRD in 42%.[3] Smoking history showed a significant difference between the dialysis and nondialysis group, where 34.4% of the dialysis group were smoker and only 16.7% of nondialysis were smoker, this may related to evidence suggesting that smoking can elevate the

Table 4: Results of echo findings

Characteristic	Nondialysis group, $n = 60$	Dialysis group, $n = 64$	P
Echo finding			
Normal	18 (30%)	12 (18.75%)	0.144C NS
Abnormal	42 (70%)	52 (81.25%)	
AR			
None	54 (90.0%)	52 (81.3%)	0.233 C NS
Mild	6 (10.0%)	10 (15.6%)	
Moderate	0 (0.0%)	2 (3.1%)	
MR			
None	52 (86.7%)	40 (62.5%)	0.001 C ***
Mild	8 (13.3%)	14 (21.9%)	
Moderate	0 (0.0%)	10 (15.6%)	
TR			
None	54 (90.0%)	50 (78.1%)	0.045 C *
Mild	6 (10.0%)	6 (9.4%)	
Moderate	0 (0.0%)	6 (9.4%)	
Sever	0 (0.0%)	2 (3.1%)	
PR			
None	55 (91.7%)	64 (100.0%)	0.050 F *
Mild	4 (6.7%)	0 (0.0%)	
LVH			
None	40 (66.7%)	22 (34.4%)	0.004 C **
Mild	14 (23.3%)	30 (46.9%)	
Moderate	4 (6.7%)	6 (9.4%)	
Sever	2 (3.3%)	6 (9.4%)	
LV systolic dysfunction			
None	50 (83.3%)	60 (93.8%)	0.075 C NS
Mild	6 (10.0%)	4 (6.2%)	
Moderate	4 (6.7%)	0 (0.0%)	
Diastolic dysfunction grade			
Normal	36 (60.0%)	38 (59.4%)	0.943 C NS
1	24 (40.0%)	26 (40.6%)	
Pericardial effusion			
Normal	60 (100.0%)	46 (71.9%)	<0.001 C ***
Small	0 (0.0%)	14 (21.9%)	
Moderate	0 (0.0%)	2 (3.1%)	
Large	0 (0.0%)	2 (3.1%)	
Global hyperkinesia			
Negative	46 (76.7%)	60 (93.8%)	0.007 C **
Positive	14 (23.3%)	4 (6.3%)	
EF %			
Normal	48 (80%)	56 (87.5%)	0.2877 NS
Decreased	12 (20%)	8 (12.5%)	

AR: aortic regurgitation, C: Chi-square test, EF: expulsion fraction, F: Fischer exact test, LVH: left ventricular hypertrophy, MR: mitral regurgitation, NS: not significant, PR: pulmonary regurgitation

*Significant at $P \leq 0.05$

**Significant at $P \leq 0.01$

***Significant at $P \leq 0.001$

risk of CKD due to several factors such as oxidative stress, pro-inflammatory state, prothrombotic changes, glomerulosclerosis, endothelial dysfunction, and tubular atrophy.[19] And this fact was approved by Orth et al. study, that shown each additional five smoked cigarettes per day was associated with an increase in serum creatinine >0.3 mg/dL by 31%.[20] Electrocardiogram is a simple, noninvasive, and readily available tool in daily routine practice. As in patients with CKD, hyperkalemia is common and life-threatening, the ability to noninvasively screen for hyperkalemia using ECG data would represent a major advance in patient care for this life-threatening condition. The current study shows that there was 21.9% of dialysis patients had a sign of hyperkalemia by ECG.

In one large cohort of patients with stages 3 and 4 CKD, the prevalence of hyperkalemia was 11%.[21] Also, the study shows that no patients on maintenance treatment for CKD had a sign of hyperkalemia by ECG and this finding goes with other study findings that showed the prevalence of hyperkalemia increases from 2% in patients with eGFR >60 mL/min/1.73 m^2% to 42% in patients with eGFR <20 mL/min/1.73 m^2.[22]

Echocardiography remains the preferred method for evaluating Valvular heart disease in CKD/ESRD patients. The present study revealed that MR was the most frequently occurring Valvular heart disease, followed by AR and TR. This finding was similar to other studies, which have also reported mitral valve disease as the predominant valvular heart disease in patients with renal insufficiency.[23-25] Another study found AR disease to be the greatest common VHD in CKD patients and ESRD patients on hemodialysis.[21,25,26]

The current study showed that only 34.4% of patients in the dialysis group had normal left ventricle, while 66.7% of patients in the nondialysis grouping, and there where an important variance in the severity of LVH among the two groups. This was similar to the finding of other studies like Laddha *et al*. study.[27] In this study, LVH was observed in 74.3% of the participants. Similarly, a study conducted by Park revealed that a decline in kidney function was considerably related to irregular LV geometry. Patients with an eGFR of 30–44 mL/min per 1.73 m^2 were found to have an upper likelihood of LVH and irregular LV geometry paralleled to those with an eGFR ≥60 mL/min per 1.73 m^2.[28] LVH may indicate augmented preload owing to hypervolemia or augmented afterload owing to elevated peripheral fighting or hypertension, conditions commonly found in CKD. Another study showed LVH as one of the common findings in patients with chronic renal disease and reflects the presence of cardiac involvement and the development of LV dysfunction.[29,30]

In the present study, mild left ventricular systolic dysfunction was detected in 6.2% of the dialysis grouping and 10% of the nondialysis grouping. This finding is reliable with a study by Wang *et al*., which reported that LV hypertrophy stayed present in nearly three-quarters of the participants and was often associated with LV dilatation and systolic dysfunction.[31]

Echocardiography-based assessment of diastolic dysfunction has revealed a great prevalence of irregularities in both dialysis and nondialysis CKD sick.[32,33] The CRIC study, which focused on stage 2–4 CKD patients, found that 71% of patients had abnormal diastolic dysfunction. In another cohort study, 85% of patients had about grade of diastolic dysfunction, and 35% showed score 2 or upper diastolic dysfunction among those on dialysis.[34] In the current study, diastolic dysfunction was approximately similar in both groups (40%). In another study, the left ventricular end-diastolic diameter in diastole, interventricular septum diameter in diastole, and posterior wall diameter in diastole decreased significantly.[35]

Pericardial effusion was found among 28.1% of patients with dialysis (21.9% of patients had mild pericardial effusion, 3.1% of sick had moderate pericardial effusion, and 3.1% of patients had severe pericardial effusion). This is due to have difficulty in maintaining an appropriate fluid balance and rapid changes in fluid levels can put stress on the heart and contribute to development of pericardial effusion, a study by Ravi et al.[36] reported a relatively higher incidence of pericardial effusion among dialysis patients, 44%. In the existing training, the occurrence of pericardial effusion was relatively higher among the dialysis patients, with 44% of them experiencing this condition. However, other studies have reported lower incidences. for example, Aghsaeifard *et al*.[37] found pericardial effusion in 13% of the patients in their study.

Global hypokinesia was found among 23.3% of patients in the nondialysis group and 6.3% of patients in the dialysis group, this finding is analogous to a training completed by Nazneen *et al*.[38] study, where a global hypokinesia found in 33.8% of patients in the nondialysis group. The training by Kartheek and Reddy's[39] study where the occurrence of global hypokinesia in patients with ESRD was 16%.

There was no significant difference in EF% between two groups, were decrease EF% was present among 20% of non-dialysis group and 12.5% of dialysis group, approximately similar finding was found by Escoli et al. study, where 19% of dialysis patients had reduce EF%.[40]

Conclusion

- Age is an important factor in CKD patients where the age in the dialysis group was 56.4 years, whereas the nondialysis group was 45 years.
- BMI was a risk factor for the dialysis group.
- Those having a history of chronic medical illness are more prone to develop renal failure.
- Echo finding was abnormal among 70% of nondialysis grouping and 81.2% of dialysis grouping.
- LVH was the most common echocardiography abnormality found between patients with CKD.
- MR was the most common valvular heart disease among patients with CKD followed by AR and tricuspid regurgitation

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Conflicts of interest
There are no conflicts of interest.

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