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Research Article

A Study of Echocardiographic Assessment of Left Ventricular Abnormalities in Patients with Chronic Kidney Disease

SR Rangabashyam[1], C Arul Murugan[2], A Arun Kumar[3], Mahesh G Patil[4]

[1]Professor and Medical Superintendent, [2]Professor and HOD, [4]Final Year Medicine Postgraduate, Department of General Medicine, Vinayaka Mission's Kirupananda Variyer Medical College and Hospital, Vinayaka Mission's Research Foundation (DU), Salem, Tamil Nadu, India.
[3]Senior Resident, Nephrology Department, Dhanalakshmi Srinivasan Medical College and Hospital, Perambalur, Tamil Nadu, India.
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I N F O

Corresponding Author:
Mahesh G Patil, Department of General Medicine, Vinayaka Mission's Kirupananda Variyer Medical College and Hospital, Vinayaka Mission's Research Foundation (DU), Salem, Tamil Nadu, India.
E-mail Id:
doc.mgpatil@gmail.com
Orcid Id:
https://orcid.org/0000-0002-1274-757X
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A B S T R A C T

Introduction: Echocardiographic abnormalities are very common in end-stage renal disease (ESRD) patients and a wide spectrum of abnormalities are noted. In order to prevent mortality, periodic echocardiographic examination for early diagnosis of cardiac abnormalities and initiation of treatment is very important. Cardiac structural changes and altered function detected by echocardiography are common in patients with Chronic Kidney Disease (CKD) before commencing haemodialysis and it is also noticed as one of the important key outcome predictors. The heart and kidney are inevitably linked with haemodynamic and regulatory functions.

Aims and Objectives: The aim was to study the prevalence of left ventricular abnormalities by echocardiography in patients with chronic kidney disease and to find out the correlation of left ventricular abnormalities and 2D echo indices with the severity of chronic kidney disease.

Materials and Methods: The study was conducted in the Department of Medicine, Vinayaka Missions Kirupananda Variyar Medical College, Salem, Tamil Nadu. 100 patients were included in the study after considering the inclusion and exclusion criteria. It was a cross-sectional study conducted from February 2020 to April 2021.

Results And Conclusion: The most common aetiology found with CKD was diabetes mellitus followed by hypertension which, in turn, was followed by obstructive uropathy and NSAID use. Among the study participants, only 20% had systolic dysfunction and only 28% had diastolic dysfunction. 72% of the study participants showed LVH and 28% had normal findings. A negative correlation was observed between systolic grading and CKD categories. No correlation was observed in our study between diastolic grading and CKD categories.

Keywords: Chronic Kidney Disease, Hypertension, Obstructive uropathy, Systolic Dysfunction, Diastolic Dysfunction

Introduction

Non-communicable diseases and other risk factors increase the burden of chronic kidney disease worldwide. KDIGO (Kidney Disease improving Global outcomes) defined chronic kidney disease according to 2012 guidelines as any functional or structural kidney abnormality, lasting for 3 months or more. The estimated global prevalence of CKD is 13.4% (11.7%-15.1%) and the patient in need of renal replacement therapy with the end-stage disease is estimated to be 4.902 million to 7.083 million. The prevalence of chronic kidney disease in India is 15-17%. It was stated in 2017 in a systematic analysis done by the global, regional and national burden of chronic kidney disease that every third person suffers from CKD in India.[1]

Chronic kidney disease can be classified based on its aetiology, glomerular filtration rate, or albuminuria.[1] It is stated by epidemiological data that 10% of the adult population suffers from CKD Grade 3-Grade 5. It also affects more than half of the high-risk sub-population. The most common impacts of this disease are concerned with serious medical, economic, and social factors. Estimated glomerular filtration rate (eGFR) reduction is considered an important predictor of CKD. In spite of advances in dialysis therapy and patient care, end-stage renal disease (ESRD) is still notable for its mortality.[2,3] The reasons for its poor prognosis include cardiovascular risk factors, non-traditional risk factors and CKD-related risk factors.[4-6]

Echocardiographic abnormalities are very common in end-stage renal disease (ESRD) patients and a wide spectrum of abnormalities is noted. In order to prevent mortality, periodic echocardiographic examination for early diagnosis of cardiac abnormalities and initiation of treatment is very important.[7] Cardiac structural changes and altered function detected by echocardiography are common in CKD patients before commencing haemodialysis. This is also noticed as one of the important key outcome predictors. The heart and kidney are inevitably linked with haemodynamic and regulatory functions. The communication between the two organs is at multiple levels which include the renin-angiotensin-aldosterone system (RAAS), sympathetic nervous system, antidiuretic hormone, endothelin and natriuretic peptides. In India, only scanty information is available on the prevalence of left ventricular hypertrophy in patients with chronic renal diseases. Thus our study was aimed at finding the prevalence of left ventricular hypertrophy by 2D echocardiography in patients with varying degrees of chronic kidney disease. This would help in the proper planning and introduction of advanced strategies for management which, in turn, will reduce the morbidity and mortality of the patients suffering from CKD.

Materials and Methods

Study Site

Department of Medicine, Vinayaka Missions Kirupananda Variyar Medical College, Salem, Tamil Nadu

Wards Included

Both paid and general rooms' patients in the Intensive Care Unit, Medical wards

Study Design

Cross-sectional study

Study Period

February 2020 to April 2021

Sample Size

The sample size was calculated based on Kumar et al.'s[8] study where the prevalence of left ventricular hypertrophy was 69%.

Sample size $n = Z_{1-\alpha/2}*p*q/d^2$,

$Z_{1-\alpha/2} = 1.96$ at 95% confidence interval,

p = Prevalence,

q = 100-p,

d = Allowable error/ margin of error

p = 69

q = 100-69 = 31

d = Relative precision (10.4)

Substituting the above values in the formula,

$N = (1.96)^2*69*31/10.4*10.4 = 8217.18/108.16 = 75.9 = 76$

Allowing a non-response rate of 20%: 76*20/100 = 15.2

So, N = 76 + 15.2

= 91.2

The final sample size attained by rounding the number was found to be 100.

Selection of Study Population

Inclusion Criteria

- All patients diagnosed with chronic kidney disease of both genders
- Patients aged more than 18 years
- Patients who had given consent to participate in the study in the mentioned wards
- Patients with comorbidity

Exclusion Criteria

- Patients with other cardiac abnormalities like congenital

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heart disease, rheumatic heart disease
- Patients who were known hypertensive for years before the onset of chronic kidney disease
- Patients with poor echo window

Statistical analysis was done using Social Sciences software version 16. Ethical committee clearance was obtained from the college ethics committee and informed consent was obtained from study participants.

Results

In our study, the most common aetiology found with chronic kidney disease was diabetes mellitus (43%), followed by hypertension (23%), obstructive uropathy (13%) and NSAID use (13%) (Table 1).

Table 1.Aetiology of Chronic Kidney Disease in the Study

S. No.	Aetiology	No. of Patients (n)	Percentages (%)
1.	Diabetes mellitus	43	43
2.	Hypertension	23	23
3.	Obstructive uropathy	13	13
4.	NSAID use	13	13
5.	SLE	4	4
6.	CKD	3	3
7.	Myeloma	1	1
Total		100	100

Study Groups

The study groups were categorised based on the glomerular filtration rate as mild chronic kidney disease, moderate chronic kidney disease, and severe chronic kidney disease as shown below:

> 60 ml/minute: Mild CKD
30-59 ml/minute: Moderate CKD
< 15-29 ml/minute: Severe CKD

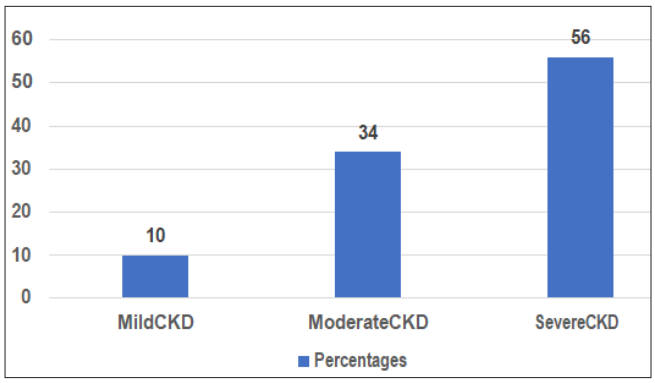

Figure 1.Categories of Study Group based on GFR

Figure 1 shows the various categories of study groups.

Age Status

Among the study participants, majority were in the middle age group of 30-39 years where 9% belonged to the moderate CKD group and 14% belonged to the severe CKD group. The second most common age group was 21-29 years where 2 subjects belonged to the mild CKD group, 6 belonged to the moderate CKD group and 13 belonged to the severe CKD group. 7% of the study population was more than 70 years of age and belonged to the severe CKD group (Figure 2).

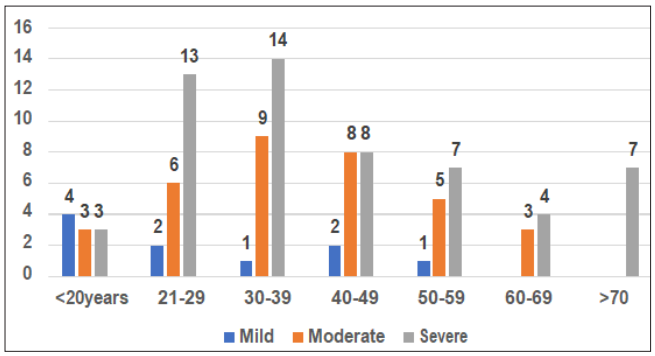

Figure 2.Age Distribution among the Study Groups

Gender

Among the study participants, majority were male (Figure 3). In mild CKD disease, most of the participants (7) were male and in moderate CKD disease, male and female participants were equal (17). In the severe CKD group, majority of the subjects were male (32) and 24 were female. A male trend was observed as the severity of chronic kidney disease progressed.

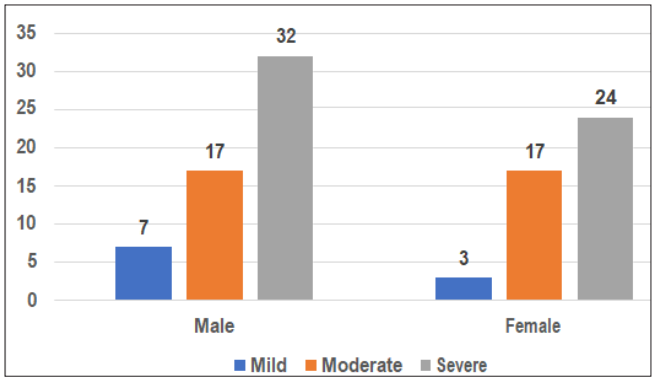

Figure 3.Gender Distribution among the Study Groups

Body Mass Index

In our study group, majority of the study participants were of normal weight (Figure 4). In the mild CKD group, all patients had a normal BMI. In the moderate CKD group, 2 study participants were found to be overweight, whereas, in the severe CKD group, 6 participants belonged to the

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overweight category and 1 participant fell in the obese category.

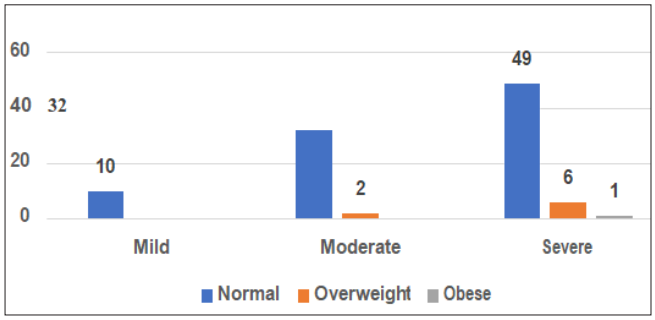

Figure 4.Body Mass Index among the Study Groups

Duration of Illness

In this study, the severity of CKD increased as the duration of illness increased (Figure 5). Majority of the study participants (20) had a duration of illness of 1-2 years in the severe CKD group, 7 in the moderate CKD group, and 3 in the mild CKD group, followed by a duration of less than 12 months. Only 7 in the severe CKD group, 4 in the moderate CKD group, and 1 in the mild CKD group suffered more than 2 years in illness.

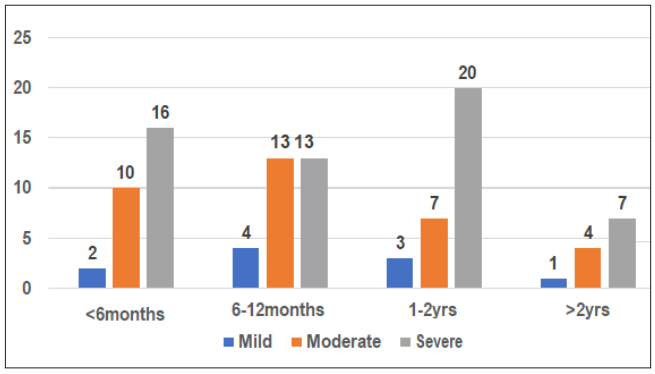

Figure 5.Duration of Illness among the Study Group

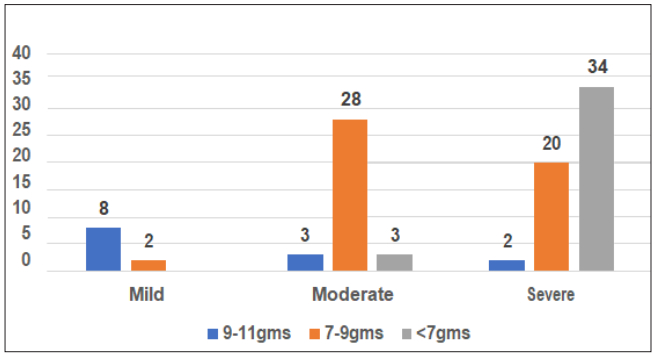

Figure 6.Haemoglobin Levels in Our Study Groups

Haemoglobin Levels in Our Study Groups

It was seen that the level of haemoglobin decreased with the increasing severity of illness (Figure 6). In the mild CKD group, 8% has mild anaemia and 2% had moderate anaemia. In the moderate CKD group, majority (28%) had moderate anaemia followed by mild and severe anaemia (3% each). In the severe CKD group, it was noted that majority of the participants had severe anaemia (34%) followed by participants with moderate anaemia (20%).

Serum Creatinine Level in the Study Groups

Among the study participants, majority had more than 6 mg/dl creatinine (Figure 7). In the mild CKD group, 7% of people had less than 3 mg/dl creatinine, whereas, in the moderate CKD group, 25% had a creatinine level of 3-6 mg/dl. Majority of the participants in the severe CKD group (47%) had more than 6 mg/dl creatinine followed by 9% with 3-6 mg/dl creatinine.

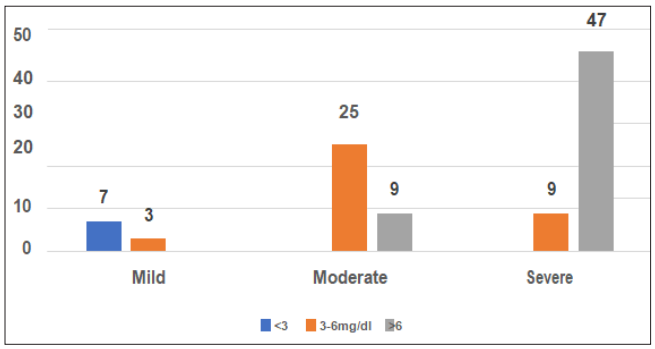

Figure 7.Serum Creatinine Level in the Study Groups

Serum Urea Level

In the mild CKD group, only 7% of the study population had less than 50 mg/dl urea whereas, the rest (3) had 50-100 mg/dl urea (Figure 8). In the moderate CKD group, around 22% of patients had 50-100 mg/dl urea followed by 10% who had 100-150 mg/dl urea. In the severe CKD group, about 29% had 100-150 mg/dl urea and only 18% had more than 150 mg/dl urea. Thus urea increases as the severity of CKD increases.

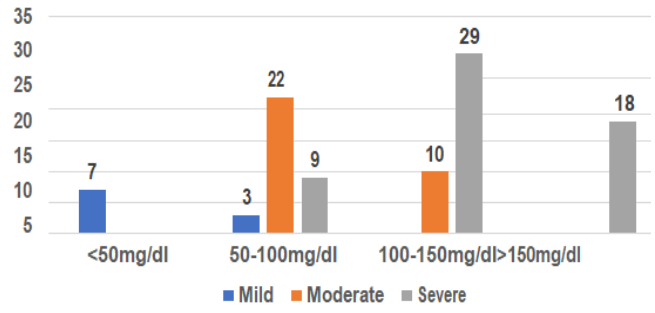

Figure 8.Serum Urea Level among the Study Groups

Among the study participants, only 20% had systolic dysfunction (Table 2).

Among our study participants, only 10% had mild systolic dysfunction, whereas 5% had moderate and 5% had severe systolic dysfunction (Table 3).

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Table 2.Left Ventricular Dysfunction on 2D Echo

Systolic Dysfunction	No. of Patients
Present	20
Absent	80

Table 3.Grading of Systolic Dysfunction

Systolic Dysfunction	No. of Patients
Mild	10
Moderate	5
Severe	5

Table 4.Left Ventricular Diastolic Dysfunction on 2D Echo

Diastolic Dysfunction	No. of Patients
Present	28
Absent	72

Table 5.Grading of Diastolic Dysfunction

Diastolic Dysfunction	No. of Patients
Grade I	20
Grade II	8

Among the study participants, only 28% had diastolic dysfunction (Table 4).

In this study, 20% of participants had mild diastolic dysfunction i.e. Grade 1, whereas 8% had Grade II diastolic dysfunction (Table 5).

58% of our study participants had LVH on the ECG (Table 6). The differences among mild, moderate, and severe CKD groups were statistically significant.

Table 6.ECG Findings in the Study

Presence/ Absence of LVH	Mild CKD	Moderate CKD	Severe CKD
Present	-	4	54
Absent	10	30	2
Chi-square	$p \leq 0.001$		

LVH in 2D Echo

In our study, it was found that 72% of the study participants showed LVH and 28% had normal findings.

In our study, the prevalence of left ventricular hypertrophy increased with the increase in stage of chronic kidney diseases and the difference is said to be statistically significant (Table 7).

Table 7.Stagewise Prevalence of Left Ventricular Hypertrophy in 2D Echocardiogram in the Study

Presence/ Absence of LVH	Mild CKD	Moderate CKD	Severe CKD
Present	-	26	46
Absent	10	8	10
Chi-square	$p \leq 0.01$		

Table 8.Correlation between LVH and the CKD stages (N = 100)

Spearman's Rho	LVH Grading	CKD Category
Correlation coefficient Sig(2-tailed)	1.000	0.694
		0.000
Correlation coefficient Sig (2-tailed)	694	1.000
	0.000	

A positive correlation was observed in our study between the LVH grading and the CKD categories (Table 8). The correlation coefficient was 0.694 which indicated a good association.

Table 9.Correlation between Systolic Dysfunction and CKD Stages (N = 100)

Spearman's Rho	Systolic Grading	CKD Category
Correlation coefficient Sig (2-tailed)	1.000	-0.73
		0.000
Correlation coefficient Sig (2-tailed)	-0.73	1.000
	0.000	

A negative correlation was observed in our study between the systolic grading and the CKD categories (Table 9). The correlation coefficient was -0.73 which indicated a significant association.

Table 10.Correlation between Diastolic Dysfunction and CKD Changes (N = 100)

Spearman's Rho	Diastolic Grading	CKD Category
Correlation coefficient Sig (2-tailed)	1.000	0.10
		0.279
Correlation coefficient Sig (2-tailed)	0.10	1.000
	0.279	

No correlation was observed between diastolic grading and CKD categories in our study (Table 10).

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The most common hypertrophy noted in our study is concentric hypertrophy (38%) followed by eccentric hypertrophy (20%) and concentric remodelling (14%) (Table 11). 28% of participants in our study had normal geometry.

Table 11.Type of LVH observed in our Study Participants

S. No.	Type of LVH Observed	No. of Patients
1.	Concentric hypertrophy	38
2.	Concentric remodelling	14
3.	Eccentric hypertrophy	20
4.	Normal geometry	28

Discussion

Prevalence of LVH in ECG

In our study, the prevalence of left ventricular hypertrophy was observed to be 58% in ECG. In a study conducted in Telangana by Reddy,[9] it was stated that LVH was found in 62.5% of the study participants.

He also stated that 22.5% of the participants had dilated LVH, 47.5% had concentric LVH, and patients who had long-term hypertension had concentric LVH.[9] Foley et al.[10] also stated in their study that the prevalence of LVH was 73.9%.

Echocardiogram Indices

In our study, 20% of the study participants had systolic dysfunction and 28% had diastolic dysfunction.

Gori et al.[11] in their study done in a Paramount trial on 217 individuals with heart failure with preserved ejection fraction stated that renal impairment was associated with high LV mass, abnormal LV geometry, and lower mid-wall fractional shortening. Park et al.[12] also noticed similar findings but without systolic dysfunction in the study done in the CRIC population.

In a cohort study done among the post-myocardial infarction patients in the Valiant trial,[13] it was found that the worst renal function is always associated with larger left atrial volume, smaller left ventricle and high LV mass index. Many studies stated that structural and functional abnormalities are noted in both right and left ventricles with mild and moderate renal impairment.

Left Ventricular Hypertrophy (LVH)

In this study, the LVH found in echocardiogram was 72%. Results of studies done in Telangana state that the prevalence of LVH was 47% which was lesser than ours and the prevalence generally varied between 16 and 31% in persons whose glomerular filtration rate is 130 ml/min.[9] It also increased to 60-75% in patients who started renal replacement therapy, and in those who underwent dialysis, it will be 70-90%. It is an important predictor in ESRD patients. It is always linked with sudden death and stroke.

Left Ventricular Systolic Dysfunction

Many studies stated that the prevalence of systolic dysfunction varies from 15-28% in dialysis patients.[14,15] It is one of the indicators which clearly states that the patient has an unfavourable prognosis. Generally, a systolic function is analysed based on ejection fraction and fractional shortening. Reddy[9] stated in their study that they observed systolic dysfunction among 27.5% of the study participants, which is higher than our study participants (20%).

Left Ventricular Diastolic Dysfunction

In this study, left ventricular diastolic dysfunction was observed in 28% of the participants. Most of the studies stated that diastolic dysfunction ranges from 50% to 65% which also includes predialysis, dialysis, and post-transplant populations. A few studies also state that early diastolic velocity is an independent prognostic value for clinical parameters.[16,17]

In a study by Reddy,[9] it was found that 50% of participants had diastolic dysfunction.

Conclusion

Our study throws light on the higher prevalence of left ventricular hypertrophy on electrocardiogram (ECG) and 2D echocardiography. It signifies the importance of cardiovascular evaluation despite the absence of symptoms in chronic kidney disease in order to reduce cardiac-related morbidity and mortality. It also imposes the treatment of anaemia and control of blood pressure which can also cause left ventricular hypertrophy.

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Conflict of Interest: None

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