



ECHOCARDIOGRAPHIC ASSESSMENT OF LEFT VENTRICULAR HYPERTROPHY IN PATIENTS OF CHRONIC RENAL FAILURE

General Medicine

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ABSTRACT

BACKGROUND AND OBJECTIVES: Left Ventricular Hypertrophy (LVH) is a major Echocardiographic finding in Chronic Renal Failure (CRF) and there is scanty information on the prevalence of Left Ventricular Hypertrophy and nature of LVH in patients with CRF. Aim of the present study is to estimate the prevalence of LVH by Echocardiography in patients with CRF and to find out Correlation of LVH with severity of CRF.

METHODS: A total of 100 Chronic Renal Failure patients admitted or who visited on out-patient basis to KMC&H, over a period of 2 years formed the study population. Detailed history, clinical evaluation, laboratory investigations, Echocardiography was carried out.

RESULTS: The Prevalence of Left Ventricular Hypertrophy in Chronic Renal failure was 69%, consisting of 67% males and 33% females, majority of the patients age group was between 51-60 years and 61-70 years. In the present study, we found that Left Ventricular Mass Index (LVMI) which reflects Left Ventricular Hypertrophy (LVH) showed a progressive rise with increase in severity of renal failure with 17% of Mild CRF category having LVH as compared to 26% of Moderate CRF category and 57% of patients of Severe CRF category having LVH.

CONCLUSION: The present study shows that patients with CRF have higher LVMI and higher prevalence of LVH, which is more marked in patients with severe CRF. The high prevalence of LVH in these populations on echocardiography implies that these patients require detailed cardiovascular evaluation despite absence of symptoms, and also that various efforts aimed at prevention and control of LVH should be started early during the course of renal insufficiency.

KEYWORDS

APKD-Adult Polycystic Kidney Disease, BSA-Body Surface Area, CGN-Chronic Glomerulonephritis, CKD-Chronic Kidney Disease CRF-Chronic Renal Failure, CVD-Cardiovascular Disease, CrCl-Creatinine Clearance, DM-Diabetes Mellitus, ESRD-End Stage Renal Disease, GFR-Glomerular Filtration Rate, HTN-Hypertension, IVSDd-Thickness of the Interventricular Septum, LVId-Internal Diameter of the Left Ventricle at End Diastole, LVH-Left Ventricular Hypertrophy, LVM-Left Ventricular Mass, LVMI-Left Ventricular Mass Index, M-Meters, PWd-Thickness of the Posterior Wall in the End Diastole

INTRODUCTION

Chronic renal failure (CRF) is defined as irreversible, substantial and usually long standing loss of renal function causing ill health.¹ Of the various causes, infection and cardiovascular events contributes towards large proportion of increased morbidity and mortality.^{2,3} Cardiac disease is the major cause of death in dialysis population accounting for 40% of deaths in International registries.

In 1997, annual report of US Renal Data System (USRDS) revealed that morbidity in patients with CRF is attributed mainly to cardiac causes which account for 49% of the cases.⁴

Left Ventricular Hypertrophy (LVH) is a major Echocardiographic finding in CRF.^{1,2,5,6} Prevalence of LVH increases with decline of renal function.³ LVH is an independent predictor of survival, present in approximately 70% of patients at the initiation of dialysis.^{3,7}

There is scanty information on the prevalence of LVH and nature of LVH in patients with CRF.⁴ Echocardiography (ECHO) should be performed early in the course of CRF and may be valuable in the monitoring of therapy of these patients.²

AIMS AND OBJECTIVES

- To Study the Prevalence of LVH by Echocardiography in Patients with CRF.
- To Find out the Correlation of LVH with Severity of CRF.

METHODOLOGY

1. Source of Data

CRF patients admitted in hospital and patients attending on OPD basis for Dialysis during the study period from November 2014 to September 2016.

2. Method of Collection of Data

The data for this study was collected from the one hundred subjects fulfilling the inclusion/ exclusion criteria admitted in KATURI MEDICAL COLLEGE AND HOSPITAL and patients on Dialysis on

OPD Basis during the study period from November 2014 To September 2016, using a pro-forma specially designed for the study.

Study Design

Descriptive Study

Sample Size 100 cases

Study Duration November 2014 to September 2016

INCLUSION CRITERIA:

The study population consists of patients with mild, moderate and severe CRF attending the hospital and patients on dialysis.

Where in^{1,4}

- Mild CRF – includes patients with Serum Creatinine 1.5-3 mg/dl
- Moderate CRF – includes patients with Serum Creatinine values 3.0-6.0 mg/dl and
- Severe CRF – includes patients with Serum Creatinine value > 6 mg/dl.

EXCLUSION CRITERIA:

- Patients with other cardiac disorder such as valvular heart disease, congenital heart disease
- Patients with poor Echo window

Methods of Sample Collection

The following set of investigations was asked for in the patients included in the study.

- Complete Hemogram
- Renal function tests
- Liver function test
- Urine analysis & culture
- Renal ultrasound
- Lipid profile
- Serum electrolytes
- Chest skiagram
- Electrocardiography-12 lead
- 2D Echocardiography All patients under went 2 dimensional

directed M- Mode Echocardiography performed in left lateral position.

The following measurements were taken in to account by using the Penn convention methods^{1,2,4}

- Thickness of Inter ventricular septum (IVSd)
- Thickness of Posterior wall in end diastole (PwD)
- Internal diameter of Left ventricle at end diastole (LVIDd)

Left ventricular mass (LVM) and Left ventricular mass index (LVMI) were calculated by using ECHO CUBE Formula recommended by American society of Echocardiography^{1,2,4}

$$\text{Left Ventricular Mass (LVM)} = 0.8 \{ [1.04 \times (\text{LVIDd} + \text{IVSd} + \text{PwD})^3 - \text{LVIDd}^3] \} + 0.6 \text{ g}$$

$$\text{Left Ventricular Mass Index (LVMI)} = \frac{\text{LVM}}{\text{Body surface area}}$$

Body surface area calculated by Dubois formula

$$\text{BSA} = 0.007184 \times \text{W}^{0.425} \times \text{H}^{0.725}$$

W – Weight in kilograms (Kgs)
H – Height in Centimeters (Cms)

Left Ventricular Hypertrophy is defined in absolute terms as:^{1,2,4}

LVMI – More than 131 g/m² in men LVMI – More than 100 g/m² in women

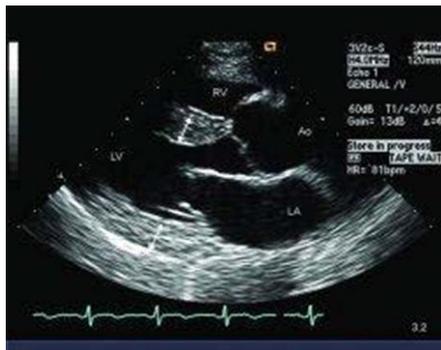
Creatinine Clearance (CrCl) is calculated according to the formula derived from Cockcroft-Gault

Cockcroft - Gault equation:

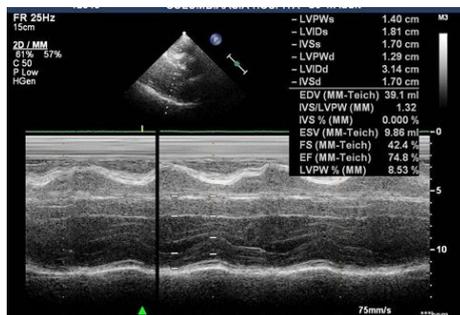
$$\text{CrCl} = \frac{\{140 - \text{Age (yrs)}\} \times \text{Weight (Kgs)}}{\text{Plasma Creatinine} \times 72} \text{ For Males}$$

$$\text{CrCl} = \frac{\{140 - \text{Age (yrs)}\} \times \text{Weight (Kgs)}}{\text{Plasma Creatinine} \times 72 \times 0.85} \text{ For Females}$$

Normal values of CrCl:
In Men - 90-139ml/min
In women - 80-135ml/min



Parasternal long axis view on transthoracic echocardiogram shows concentric LVH



Echocardiography showing the measurement of Gradients in LVH

OBSERVATIONS AND RESULTS

The present study comprised 100 cases of chronic renal failure admitted to KATURI MEDICAL COLLEGE AND HOSPITAL, GUNTUR during the study period from November 2014 To September 2016.

1. Age Distribution:

Table – 1: Showing age distribution of 100 cases of CRF

Age group (years)	Frequency	Percentage
41 – 50	17	17 %
51 – 60	31	31 %
61 – 70	41	41 %
71 – 80	11	11 %
Total	100	100 %

2. Gender Distribution:

Table 2: Showing the Gender Distribution

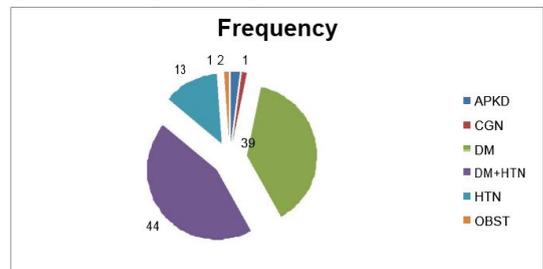
Gender	Frequency	Percentage
F	33	33 %
M	67	67 %
Total	100	100 %

3. Etiology of CRF:

Table – 3: Showing the etiology of CRF

Etiology of CRF	Frequency	Percentage
DM + HTN	44	44 %
DM	39	39 %
HTN	13	13 %
APKD	2	2 %
CGN	1	1 %
Obstructive	1	1 %
Total	100	100 %

Graph – 1: Showing the Etiology of CRF



4. Serum Creatinine levels:

Table – 4: Showing the Distribution of Serum Creatinine

Level of Serum Creatinine (mg/dl)	Frequency	Percentage
1.5 - 3.0 (Mild CRF)	20	20 %
3.0 - 6.0 (Moderate CRF)	40	40 %
> 6.0 (Severe CRF)	40	40 %
Total	100	100 %

The range of Serum Creatinine level in the present study was between 1.5-20.8mg/dl. However, 80 patients (80%) were equally distributed in moderate and severe CRF group (i.e., 40% in each group) and remaining 20% were in the Mild CRF group.

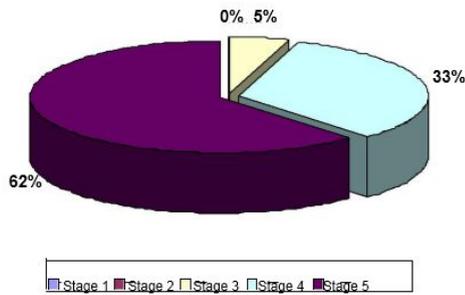
5. Severity based on Creatinine clearance (CrCl)

Table – 5: Distribution based on CrCl

Stage	No of cases	%
Stage 1 [Signs of mild kidney disease with normal or better GFR; GFR >=90%]	0	0.00
Stage 2 [Mild kidney disease with reduced GFR; GFR 60-89%]	0	0.00
Stage 3 [Moderate chronic renal insufficiency; GFR 30-59%]	5	5.00
Stage 4 [Severe chronic renal insufficiency; GFR 15-29%]	33	33.00
Stage 5 [End stage renal disease; GFR <15%]	62	62.00
Total	100	100

Graph – 2: Showing the Distribution based on CrCl

Stages



In the present study, CrCl<15% was seen in 62% of patients and CrCl between 15-29% was seen in 33% of patients.

6. Electrocardiographic (ECG) Changes in CRF:

Table – 6: Showing the ECG Changes

Particulars	Frequency	Percentage
LVH	69	69 %
NO LVH	31	31 %
Total	100	100 %

In the present study, ECG abnormalities i.e., Left ventricular hypertrophy was seen in 69 patients (69%).

7. Echocardiographic Changes in CRF:

Table – 7: Showing ECHO Changes

Echo changes	Frequency	Percentage
NO LVH	31	31 %
LVH	69	69 %
Total	100	100 %

In the present study, out of the 100 patients with CRF, 69 patients(69%) had Left Ventricular Hypertrophy and 31 patients(31%) had no signs of left ventricular hypertrophy.

8. Comparing with severity of CRF with Presence of LVH on 2D-Echo:

Table – 8: Showing the data comparing with severity of CRF with presence of LVH or not on Echo:

SEVERITY OF CRF	LVH	%	NO LVH	%
MILD CRF	12	17 %	9	29 %
MODERATE CRF	18	26 %	17	55%
SEVERE CRF	39	57 %	5	16 %
TOTAL	69	100 %	31	100 %

GRAPH – 3: Graph showing the distribution of patients based on severity of CRF with echo changes:

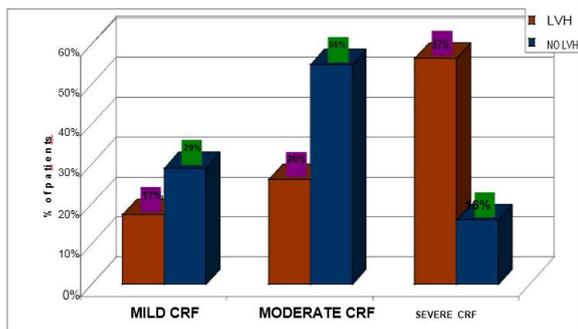


TABLE – 9: Analysis based on CrCl:

Parameter	Severe (a)	Moderate (b)	Mild (c)	P-Value
CrCl	7.90±2.94	14.93±2.34	25.81±9.18	a vs b <0.001 a vs c <0.001 b vs c <0.001

In the present study we observed that there is a significant difference in mean CrCl between patients with severe CRF and moderate CRF as well as mild CRF (P<0.001).The difference in mean CRF between

patients with moderate CRF and mild CRF is also statistically significant (P<0.001).Higher mean CrCl is found in patients with mild CRF followed by patients with moderate CRF and severe CRF respectively and the difference in mean CrCl between them is found to be statistically significant.

TABLE – 10: Analysis based on etiology with the severity of CRF:

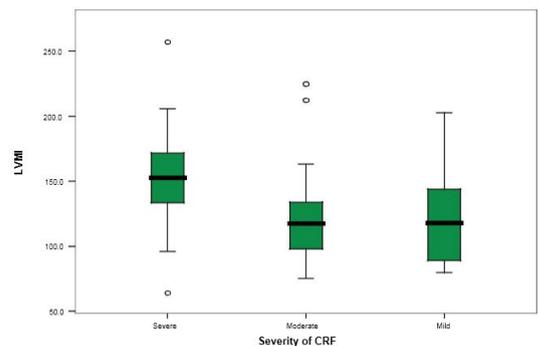
Etiology	Severity of CRF			Total
	Severe	Moderate	Mild	
APKD	2	0	0	2
CGN	0	0	1	1
DM	15	16	8	39
DM+HTN	21	16	7	44
HTN	7	2	4	13
OBSTRUCTION	0	0	1	1
Total	45	34	21	100

TABLE – 11: Analysis of echocardiographic parameters in the study sample

Parameter	Severe [a]	Moderate [b]	Mild [c]	P-Value
LVIDd	4.56±0.54	4.29±0.35	4.37±0.50	a vs b <0.05* a vs c >0.05 b vs c >0.05
LVPWd	1.35±0.21	1.23±0.22	1.23±0.25	a vs b >0.05 a vs c >0.05 b vs c >0.05
IVSd	1.36±0.18	1.20±0.22	1.21±0.15	a vs b <0.01* a vs c <0.05* b vs c >0.05
LVM	243.99±73.71	195.31±65.38	204.50±65.78	a vs b <0.01* a vs c >0.05 b vs c >0.05
LVMi	153.59±36.46	120.66±38.40	123.24±38.16	a vs b <0.01* a vs c <0.01* b vs c >0.05

* denotes a significant difference

BOX PLOT OF LVMi IN THE THREE CATEGORIES OF CRF GROUP:



Higher mean LVIDd is recorded in patients belonging to severe CRF category followed by moderate and mild CRF categories respectively.

The difference in mean LVIDd between severe and moderate categories was found to be statistically significant (P<0.05), but was not statistically significant between mild and moderate categories as well as mild and severe categories (P>0.05). No statistically significant difference was observed in the mean LVPWd values recorded between the groups (P>0.05).Higher mean LVPWd was found in patients in severe CRF category and it was almost same in patients in moderate and mild categories.

The mean IVSd was found to be higher in patients belonging to severe CRF category followed by mild and moderate CRF categories. The mean difference in IVSd was found to be statistically significant between severe and moderate as well as severe and mild categories (P<0.05). However, the mean difference was not statistically significant between mild and moderate categories (P>0.05).

The difference in mean LVM between severe and moderate CRF categories was found to be statistically significant (P<0.01). But the

difference in mean LVM between severe and mild as well as mild and moderate CRF categories was not statistically significant ($P>0.05$). No statistically significant difference was observed between patients of mild and moderate CRF levels with respect to mean LVMI ($P>0.05$). But the difference in mean LVMI between moderate and severe category as well as mild and severe category was found to be statistically significant ($P<0.01$)

DISCUSSION

Premature cardiovascular disease is a significant cause of morbidity and mortality among patients with CRF. Four main structural abnormalities of the heart have been described in patients with CRF: LV hypertrophy, expansion of the nonvascular cardiac interstitium leading to inter-myocardiocytic fibrosis, changes in vascular architecture, and myocardial calcification.

All these abnormalities promote systolic as well as diastolic LV dysfunction which predisposes to symptomatic heart failure, which is a risk factor for premature death.

Echocardiography provides an excellent non-invasive method to delineate details of the anatomy of cardiac cavity, wall dimensions and wall movements. It is now increasingly used in the assessment of cardiac performance and is also invaluable in the demonstration of structural abnormalities such as LVH and pericardial effusion.

Left ventricular hypertrophy is the single strongest independent predictor of adverse cardiovascular events. LVH is a major echocardiographic finding in uremic patients.

In the present study, we found that LVMI showed a progressive rise with increase in severity of renal failure. This is in concordance with the study done by Agarwal S et al², Adeera Levin et al³, Dangiri P et al⁴ who also found a similar trend of LVMI in patients of CRF.

In the present study, out of 100 patients 69 (69%) patients had Left Ventricular Hypertrophy on Echocardiography which is comparatively similar to study done by Adeera Levin et al³ (70%), as compared to other studies done by Yashpal et al⁸ (15.49%), Chafekar D S et al⁹ (17.6%), Parfrey P S et al¹⁰ (41%), Rachel J Middleton, et al¹¹ (41%), Tomilina N A et al (52.6%), Kale S A et al¹² (54.7%), Goran J Paunovic et al¹³ (56.9%), Sanchari Datta et al¹⁴ (77%).

Of the 69% of patients with LVH, 12(17.39%) patients were from Mild CRF Category, 18(26%) patients were from Moderate CRF category and 39(56.52%) patients were from severe CRF category respectively as compared to 40% in Mild and Moderate and 97% in Severe CRF categories as shown by Dangiri P et al⁴ and 30% in Mild/Moderate category and 53.2% in Severe Category as shown by Agarwal S et al.²

In CKD patients, left ventricular hypertrophy (LVH) is a common finding and it is associated with an increased CVD-related mortality¹⁵. In this study, LV hypertrophy was observed in all patients, but it was slightly more pronounced in patients with stage IV and V. The occurrence of LVH in this study was higher compared to that observed by Hayashi *et al.*¹⁴ 63% in CKD patients stage I, II and III and 66% in CKD stage IV–V. Studies indicates that the prevalence of LVH increases to 60–75% in patients beginning renal replacement therapy, and reaches 70–90% in patients on regular dialysis^{16,17}

According to Levin *et al.*³ the prevalence and severity of LVH increases along with the progression of chronic kidney disease. At first, LVH is a physiological response to pressure and volume overload, but then when combined with anemia and hyperparathyroidism it may turn into maladaptive LVH characterized by structural changes in the myocardium, such as collagen accumulation, fibrosis and calcification, which lead to systolic and diastolic dysfunction¹⁵.

In patients on dialysis arterio-venous fistula reduces systemic vascular resistance and increases stroke volume load on the left ventricle which may contribute to LVH and may result in LV systolic and diastolic dysfunction with time. Also Rosello *et al.*¹⁸ suggested that LVH contribute to diastolic LV dysfunction.

According to Masugata *et al.*¹⁹ LV hypertrophy may be superior to LV diastolic dysfunction in predicting low eGFR in patients with CKD using echocardiography.

Hayashi *et al.*¹⁵ suggested that LV geometry can affect systolic function since eccentric LVH has been described to be more frequently associated with systolic dysfunction than concentric LVH¹⁵. However, in this study systolic function remained within normal limits in all patients, even in those with end-stage renal disease.

CONCLUSIONS AND SUMMARY

The present study shows that patients with CRF have higher LVMI and higher prevalence of LVH, and also with respect to category of CRF, the LVH prevalence progressively increases with increasing severity of CRF Category.

The high prevalence of LVH in these populations on echocardiography implies that these patients require detailed cardiovascular evaluation despite absence of symptoms, and also that various efforts aimed at prevention and control of LVH should be started early during the course of renal insufficiency.

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