e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(5); 659-668

Original Research Article

Echocardiographic Assessment of Left Ventricular Hypertrophy in Patients with Chronic Renal Failure: A Descriptive Study

S Narasimhamurty[1], S S V V Narasinga Rao[2], T.V.S.R. Raghu*[3]

[1]Associate Professor, Department of General Medicine, Government Medical College, Srikakulam
[2]Assistant Professor, Department of General Medicine, Government Medical College, Srikakulam
[3]Associate Professor, Department of General Medicine, Government Medical College, Srikakulam

Received: 25-02-2024 / Revised: 23-03-2024 / Accepted: 26-04-2024
Corresponding Author: Dr. T.V.S.R. Raghu
Conflict of interest: Nil

Abstract:

Background and Objectives: Chronic Renal Failure (CRF) prevalence has increased, leading to increased admissions and decreased life expectancy. Causes include infection and cardiovascular events, with Left Ventricular Hypertrophy being a major finding. However, there's limited information on its prevalence and nature.

The study aims to estimate Left Ventricular Hypertrophy prevalence in patients with Chronic Renal Failure using Echocardiography and determine its correlation with the severity of the condition.

Methods: The study involved 100 Chronic Renal Failure patients admitted or visiting GMC, GGH, SRIKAKULAM over two years, undergoing detailed history, clinical evaluation, laboratory investigations, and Echocardiography.

Results: The study found that Left Ventricular Hypertrophy (LVH) prevalence in chronic renal failure patients increased with severity, with 17% in mild cases, 26% in moderate cases, and 57% in severe cases, primarily among patients aged 51-60 years.

Conclusion: The study reveals that patients with chronic renal failure have a higher left ventricular mass index and a higher prevalence of left ventricular hypertrophy, particularly in severe cases. This suggests the need for early cardiovascular evaluation and prevention efforts.

Keywords: Chronic Renal Failure, Echocardiography, Left Ventricular Hypertrophy, Creatinine Clearance.

Introduction

Chronic Renal Failure (CRF) is a prevalent medical condition affecting patients' lives, affecting all body systems and causing various abnormalities. [1]Chronic renal failure, caused by infection and cardiovascular events, leads to increased morbidity and mortality, with cardiac disease being the major cause of death in dialysis populations.[2,3,5]

The US Renal Data System's 1997 annual report revealed that cardiac causes account for 49% of patients with Chronic Renal Failure (CRF).[2]

Left Ventricular Hypertrophy (LVH) is a significant echocardiographic finding in Chronic Renal Failure (CRF), increasing with renal function decline and predicting survival in 70% of patients.[6,7]

Limited information on Left Ventricular Hypertrophy prevalence in CRF patients; echocardiography should be performed early for therapy monitoring. Age, sex, hypertension, and anemia are significant risk factors.[3]

Aims and Objectives

The study aims to investigate the prevalence of left ventricular hypertrophy in patients with chronic renal failure and its correlation with the severity of the condition.

Methodology

The study analyzed patients with chronic renal failure admitted to hospitals and those attending on an out-of-pocket basis for dialysis from December 2021 to September 2023.

This study surveyed 100 patients in GMC, GGH, SRIKAKULAM, Nephrology unit and those on OPD-based dialysis from December 2021 to September 2023 using a specially designed proforma.

Study Design: Descriptive Study.

Sample Size: 100 cases.

Study Duration: February 2022 to January 2024.

Inclusion Criteria: The study focuses on patients with mild, moderate, and severe Chronic Renal Failure, including those on dialysis, with Serum creatinine values ranging from 1.5-3 mg/dl.

Underlying cause of CRF:

1. Diabetic nephropathy
2. Hypertensive nephropathy
3. Chronic Glomerulonephritis
4. Chronic Tubulointerstitial disease
5. Autosomal dominant polycystic kidney disease

Exclusion Criteria:

Patients with other cardiac disorders like valvular heart disease and congenital heart disease, as well as those with poor echo window, and those at risk of heart disease.

Methods of Sample Collection

The study involved various investigations including a complete haemogram, renal function tests, liver function tests, urinalysis, renal ultrasound, lipid profile, serum electrolytes, calcium, phosphorus, chest X ray, electrocardiography-12 lead, and 2D echocardiography. Patients underwent 2D directed M-Mode Echocardiography in left lateral position using Penn convention methods1, 2, and measurements were taken.[1,2,3]

- Thickness of Interventricular septum (IVSd)
- Thickness of Posterior wall in end diastole (PWd)
- Internal diameter of Left ventricle at end diastole (LVIDd)

The American Society of Echocardiography recommends using the ECHO CUBE Formula to calculate Left Vessel Mass (LVM) and Left Vessel Mass Index (LVMI). [1,2,3]

Left Ventricular Mass (LVM) = 0.8 {[1.04x (LVIDd+IVSd+PWd)^3 -LVIDd^3]}+0.6 g

Left Ventricular Mass Index (LVMI) = LVM /Body surface area

Body surface area calculated by Dubois formula - BSA = 0.007184 x W$^{0.425}$ x H$^{0.725}$

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

Left Ventricular Hypertrophy is defined in absolute terms as: [1,2,3]

- LVMI – More than 131 g/m^2 in men
- LVMI – More than 100 g/m^2 in women

CreatinineClearance**(CrCl)** is calculated according to the formula derived from Cockcroft-Gault

Cockcroft-Gault equation:

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

$$CrCl = \frac{\{140 - Age\,(yrs)\} \times Weights\,(Kgs)}{Plasma\,Creatinine \times 72} \times 0.85 \quad \text{for Females}$$

Normal values of Creatinine Clearance:

In Men - 90- 139ml/min

In Women- 80-135ml/min

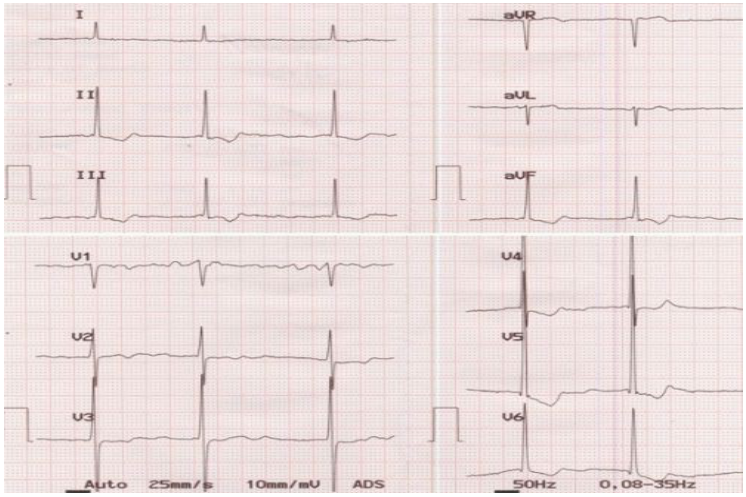

Figure 1: 12 Lead Electrocardiogram Showing Left Ventricular Hypertrophy with Strain

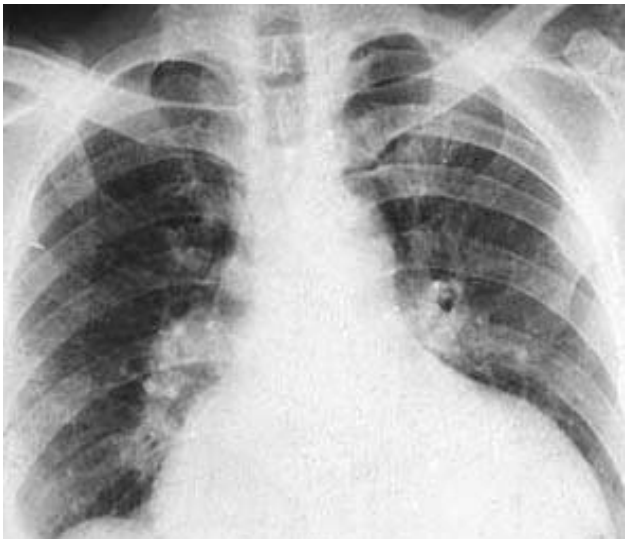

Figure 2:Chest X Ray Showing Cardiomegaly (LV APEX)

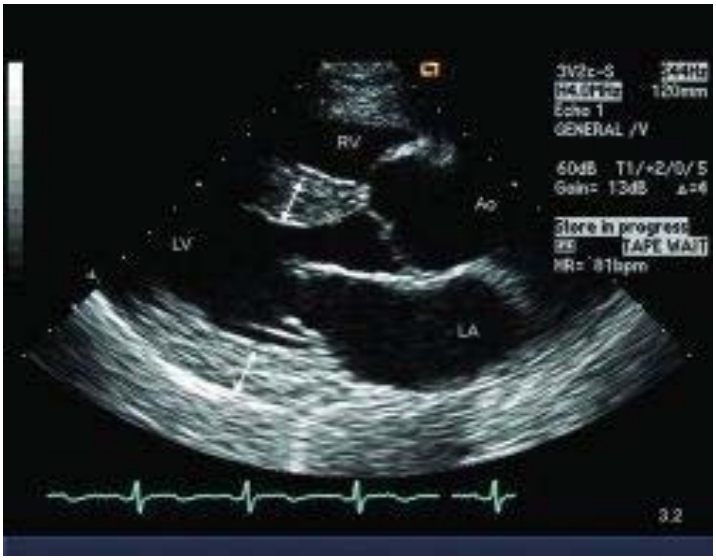

Figure 3:Parasternal long axis view on transthoracic echocardiogram shows concentric left ventricular hypertrophy

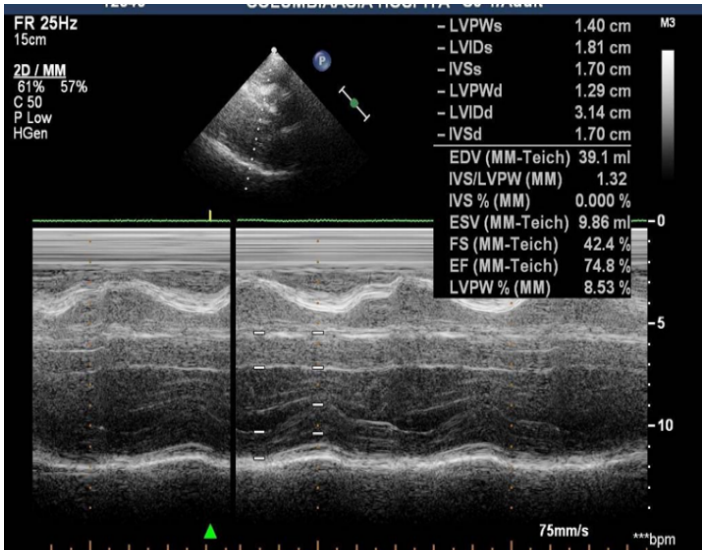

Figure 4:Echocardiography showing the measurement of Gradients in Left Ventricular Hypertrophy

Results: The study involved 100 chronic renal failure cases admitted to GMC, GGH, SRIKAKULAM, Nephrology unit, from December 2021 to September 2023.

1. Age Distribution:

Table 1: Showing age distribution of 100 cases of chronic renal failure

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

The study analyzed patients aged 41-80, with 41% falling within the 61-70 age group.

2. Gender Distribution:

Table 2: Showing the Gender Distribution

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

The study group, as depicted in table 2, consisted of 67% males and 33% females.

3. Etiology of CRF:

Table 3: Showing the etiology of chronic renal failure

Etiology of Chronic renal failure	Frequency	Percentage
Diabetes + Hypertension	44	44 %
Diabetes Mellitus	39	39 %
Hypertension	13	13 %
APKD	2	2 %
Chronic glomerulonephritis	1	1 %
Obstructive	1	1 %
Total	100	100 %

The study found that diabetes and hypertension were the leading causes of chronic renal failure in 44 patients, followed by diabetes in 39, hypertension in 13 patients, and obstructive pathology in 1 patient.

4. Blood Urea Levels

Table 4: Showing the distribution of Blood Urea levels

Level of Blood Urea (mg/dl)	Frequency	Percentage
50 -100	30	30 %
101-150	40	40 %
151-200	26	26%
> 200	4	4%
Total	100	100%

The study found that 40% of patients had blood urea levels between 101-150 mg/dl, while 30% had levels between 50-100 mg/dl.

5. Serum Creatinine Levels:

Table 5: 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 study found that 80% of 80 patients were divided into moderate and severe CRF groups, with the remaining 20% in the mild CRF group.

6. Severity Based on Creatinine Clearance

Table 6: Distribution based on Creatinine clearance

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; GFR60-89%]	0	0.00
Stage 3 [Moderate chronic renal insufficiency; GFR 30- 59%]	5	5.00
Stage 4 [Severe chronic renal insufficiency; GFR15-29%]	33	33.00
Stage 5 [End stage renal disease; GFR <15%]	62	62.00
Total	100	100

The study found that 62% of patients had a CrCl below 15%, while 33% had a CrCl between 15-29%.

7. Range of Hemoglobin Levels in CRF:

Table 7: Showing the distribution of the levels of Hemoglobin

Level of Hb% (gm %)	Frequency	Percentage
5.1 - 7.0	19	19 %
7.1 - 9.0	50	50 %
9.1 - 11	29	29 %
> 11	2	2 %
Total	100	100 %

The study found that 50% of patients had hemoglobin levels between 7.1-9 gm%, while 29% had levels between 9.1-11 gm%.

8. Serum Potassium Levels in CRF:

Table 8: Showing levels of Serum Potassium

Level of Sr.Potassium mEq/L	Frequency	Percentage
<3	1	1 %
3.1 - 4.0	21	21 %
4.1 - 5.0	40	40 %
5.1 - 7	38	38 %
Total	100	100 %

The study found that 40% of patients had Serum Potassium levels between 4.1-5 mEq/L, while 1% had levels below 3%.

9. Serum Calcium Levels in CRF:

Table 9: Showing levels of Serum Calcium

Levels of Sr.Calcium mg/dl	Frequency	Percentage
6 – 7	9	9 %
7.1 - 8.0	21	21 %
8.1 – 9	38	38 %
9.1 – 10	21	21 %
10.1 – 11	10	10 %
> 11	1	1 %
Total	100	100 %

The study found that 38% of 38 patients had serum calcium levels between 8.1-9 mg/dl, ranging from 6-11.2 mg/dl.

10. Serum Phosphorus Levels in CRF:

Table 10: Showing levels of Serum Phosphorus

Levels of Sr.Phosphorus mg/dl	Frequency	Percentage
2 - 4	19	19 %
4.1 - 5.0	46	46 %
5.1 - 6	27	27 %
6.1 - 7	6	6 %
> 7	2	2 %
Total	100	100 %

The study found that 46% of the 46 patients had serum phosphorus levels between 4.1-5 mg/dl, within the range of 2.9-7.4 mg/dl.

11. Total Cholesterol Levels in CRF:

Table 11: Showing serum Cholesterol levels

Level of Total Cholesterol (mg/dl)	Frequency	Percentage
< 150	5	5 %
151 - 200	63	63 %
> 200	32	32 %
Total	100	100 %

The study found that total cholesterol levels varied among patients, with 63% having levels between 151-200 mg/dl and 32% having levels above 200 m/dl.

12. Triglycerides Levels in CRF:

Table 12: Showing Triglycerides levels in CRF

Level of Triglycerides (mg/dl)	Frequency	Percentage
< 150	14	14 %
151 - 170	57	57 %
> 170	29	29 %
Total	100	100

13. LDL Cholesterol Levels In CRF:

Table -13: Showing LDL levels in CRF

Level of LDL Cholesterol mg/dl	Frequency	Percentage
< 100	13	13 %
101 – 130	67	67 %
> 130	20	20 %
Total	100	100 %

The study found that 67% of the 67 patients had LDL cholesterol levels between 101-130 mg/dl, within the range of 96-148 mg/dl.

14. HDL Cholesterol Levels In CRF:

Table 14: Showing HDL Cholesterol levels

Level of HDL Cholesterol (mg/dl)	Frequency	Percentage
< 30	52	52 %
31 - 40	34	34 %
> 40	14	14 %
Total	100	100 %

The study found that 52% of 52 patients had HDL cholesterol levels below 30 mg/dl, within the range of 24-48 mg/dl.

15. Electrocardiographic Changes in CRF:

Table 15: Showing the Electrocardiographic Changes

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

The study revealed that 69% of the 69 patients had left ventricular hypertrophy, an electrocardiographic abnormality.

16. Echocardiographic Changes in CRF:

Table 16: Showing Echocardiographic Changes

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

The study found that 69% of 100 patients with CRF had left ventricular hypertrophy, while 31% had no signs of left ventricular hypertrophy.

17. Comparing With Severity of CRF with Presence of LVH On 2d-Echo:

Table 17: 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 %**

Table 18: Analysis of Biochemical Parameters According To Severity of CRF

Parameter	Severe [a]	Moderate [b]	Mild [c]	P-Value
Age (yrs)	59.25±10.18	60.18±7.76	63.05±7.59	
Blood Urea (mg/dl)	159.15±36.30	104.03±38.00f	91.24±35.70	a vs b <0.001*
				a vs c <0.001*
				B vs c >0.05
Serum Creatinine (mg/dl)	10.13±3.90	4.21±0.78	2.35±0.38	a vs b <0.001*
				a vs c <0.001*
				b vs c <0.05*
Creatinine Clearance (ml/min)	7.90±2.74	14.93±2.33	25.81±9.17	a vs b <0.001*
				a vs c <0.001*
				b vs c <0.001*
Hemoglobin (gm %)	11.5±0.17	13.1±0.22	13.8±0.30	a vs b <0.001*
				a vs c <0.001*
				B vs c >0.05
Total Cholesterol	207.22±30.40	190.67±23.10	196.09±44.90	A vs b >0.05
				A vs c >0.05
				B vs c >0.05
Triglycerides	163.25±19.60	164.64±9.32	166.85±14.90	A vs b >0.05
				A vs c >0.05
				B vs c >0.05
LDL Cholesterol	113.52±13.2	121.97±11.9	124.28±12.5	a vs b <0.05*
				a vs c <0.01*
				b vs c >0.05
HDL Cholesterol	31.66±4.64	32.56±5.77	36.33±6.06	a vs b >0.05
				a vs c <0.01*
				b vs c <0.05*
Sr. Potassium (mEq/l)	4.81±0.87	4.88±0.99	4.39±0.67	a vs b >0.05
				a vs c >0.05

				b vs c >0.05
Sr. Calcium (mg/dl)	8.47±0.97	8.85±0.87	8.93±1.29	a vs b >0.05
				a vs c >0.05
				b vs c >0.05
Sr. Phosphorus (mg/dl)	4.58±0.99	5.23±0.80	4.95±0.96	a vs b <0.01*
				a vs c >0.05
				b vs c >0.05
SBP (mm of Hg)	134.00±17.55	133.41±16.50	131.62±15.92	a vs b >0.05
				a vs c >0.05
				b vs c >0.05
DBP (mm of Hg)	86.45±7.83	88.00±6.84	85.62±7.99	a vs b >0.05
				a vs c >0.05
				b vs c >0.05

*** Denotes a significant difference**

The study found significant differences in mean blood urea levels among patients with severe, moderate, and mild Chronic Respiratory Failure (CRF). Severe CRF patients had higher mean blood urea levels compared to moderate and mild CRF patients.

Serum creatinine levels were higher in severe CRF patients, followed by moderate and mild patients. Creatinine clearance levels were higher in mild and severe CRF patients. Hemoglobin levels were lower in severe CRF patients compared to mild and moderate patients, but not between mild and moderate categories.

The study found that patients with severe coronary artery disease (CAD) had higher mean total cholesterol levels, higher LDL levels, lower HDL levels, higher mean serum potassium (mEq/l), lower mean serum calcium (mg/dl), higher mean serum phosphorus (mg/dl), and no statistically significant difference between mild and severe categories. However, no significant difference was observed between mild and moderate categories. The mean CRF was significantly higher in patients with severe CRF compared to those with moderate and mild CRF. The mean serum potassium was higher in patients with moderate CRF, but not in severe CRF. The mean serum phosphorus was higher in patients with moderate CRF, but not in mild or severe categories. No significant difference was found between the severity of CRF levels with respect to age, SBP, and DBP.

Table 19: Analysis Based on Creatinine Clearance:

Parameter	Severe (a)	Moderate (b)	Mild (d)	P-Value
Cr Clear	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

The study found a significant difference in mean Cr Clear between patients with severe CRF, moderate CRF, and mild CRF (P<0.001). Moderate CRF and mild CRF patients had higher mean Cr Clear, followed by mild CRF patients and moderate CRF patients, with a statistically significant difference.

Table 20: Analysis Based on Etiology with the Severity of Chronic Renal Failure:

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
OBST	0	0	1	1
Total	**45**	**34**	**21**	**100**

Table 21: 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**

The study found that patients with severe chronic obstructive pulmonary disease (CRF) had higher mean LVIDd, LVPWd, IVSd, LVM, and LVMI. The difference in LVIDd was statistically significant between severe and moderate categories, but not between mild and moderate categories. No significant difference was observed in LVPWd values between the groups. The mean IVSd was higher in severe and moderate categories, but not between mild and moderate categories. The difference in mean LVM between severe and moderate categories was statistically significant, but not between mild and moderate categories. No significant difference was observed in mean LVMI between patients with mild and moderate CRF levels.

Discussion

Premature cardiovascular disease (CRF) is a major cause of morbidity and mortality in patients with CRF. Four main heart structural abnormalities include left ventricular hypertrophy, expansion of the nonvascular cardiac interstitium, changes in vascular architecture, and myocardial calcification.

These abnormalities promote systolic and diastolic LV dysfunction, leading to symptomatic heart failure and premature death. Diagnostic modalities like electrocardiography, echocardiography, and radionuclide scans are used to diagnose left ventricular hypertrophy and dysfunction. Left ventricular hypertrophy is the strongest independent predictor of adverse cardiovascular events. The study reveals a progressive rise in LVMI with increasing severity of renal failure, consistent with previous research by Dangiri et al [2], Agarwal et al [3], and Adeera Levin et al [5]., which also found similar trends.

The study found that 50% of patients had hemoglobin levels between 7.1-9 gm%, 40% had serum potassium levels between 4.1-5 mEq/L, 38% had serum calcium levels between 8.1-9 mg/dl, and 46% had serum phosphorus levels between 4.1-5 mg/dl, all consistent with previous studies.[4] The study found that 86% of patients had HDL cholesterol levels below 40 mg/dl, similar to previous studies by Dangri P et al., 29% had triglycerides above 170 mg/dl, and 32% had cholesterol levels above 200 m/dl. Out of 100 patients, 69% had Left Ventricular Hypertrophy on Echocardiography, similar to previous studies by Adeera Levin et al [5]. and Yashpal et al, but with lower values. The findings suggest that addressing these health issues can improve overall health outcomes. Out of 69% of patients with LVH, 17.39% were classified as mild, 26% as moderate, and 56.52% as severe Chronic Renal Failure, compared to 40% in mild and moderate, 97% in severe, and 30% in mild/moderate.[3]

Conclusion

Chronic Renal Failure patients have higher left ventricular mass index and prevalence of left ventricular hypertrophy, with LVH prevalence increasing with severity. This suggests that detailed cardiovascular evaluation is necessary despite absence of symptoms, and early efforts to prevent and control left ventricular hypertrophy should be initiated, including effective hypertension and anemia control.

References:

1. Nahas E L and Winerals C G. Chronic renal failure 20.17.1 In: Oxford Textbook of Medicine. 3rd ed., DJ Weatherall, et al. Oxford Medical Publications USA. 1996; 3: 3294-3306.
2. Dangri P, Agarwal S, Kaira O P, Rajpal S. Echocardiographic assessment of the left ventricle hypertrophy in patients of chronic renal failure. Indian Journal of Nephrology. 2003; 13: 92-97.
3. Agarwal S, Dangri P, Kaira O P, Rajpal S. Echocardiographic assessment of cardiac dysfunction in patients of chronic renal failure. JIACM. 2003;4(4): 296-303.
4. Tomilina N A, Volgina G V, Bikbov B T, Perepechyonickh Yu V, II Stenina Moscw Russia. Prevalance of the left ventricular hypertrophy and geometric modelling in patients with chronic renal failure. 2nd International Congress of Nephrology in Internet. 16/09/2007; 1-12.
5. Adeera Levin, Joel Singer, Christopher R, Thompson, Heather Ross and Mary Lewis RN.

Prevalent Left Ventricular in the Predialysis Population: Identifying opportunities for intervention. American Journal of kidney Diseases, March, 1996;27(3): 347-354.

6. Kerstin Amann, Ivan Rychlik, Gabriel Miltenberger-Milteny, Eberhard Ritz. Left ventricular hypertrophy in renal failure. Kidney International, 1998; 54(Suppl. 68): S-78-S-85.