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Echocardiographic Assessment of Left Ventricular Hypertrophy in Patients with Chronic Kidney Disease in Different Age Groups

Nagarjuna T[1], Annamalai S[2], Begum N[3] and Chandran M[4]

[1]Resident, Department of General Medicine

[2]Professor and Dean , SSSMC & RI,

[3]Professor and Head of the Department of General Medicine,4 Assistant Professor,Department of General Medicine Shri Sathya Sai Medical College & Research Institute (SSSMC & RI),Sri Balaji Vidyapeeth

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***Corresponding Author:**

Nagarjuna T,

Resident, Department of General Medicine,

E-mail :nagarjunatalasila@gmail.com

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1. Abstract

1.1. Introduction: Chronic Kidney Disease (CKD) is characterised by impaired kidney function and a gradual Decrease In Glomerular Filtration Rate (GFR). In CKD, Left Ventricular Hypertrophy (LVH) is a common sign. This study was done with an objective to estimate the prevalence of LVH by echocardiography in patients with CKD and to find out its correlation with severity of CKD.

1.2. Methodology: This was a cross sectional study done at a tertiary care teaching institution for a period of 18 months among 125 CKD patients who were admitted in hospital or attended on OPD basis. Detailed history, clinical evaluation, laboratory investigations and echocardiography was carried out using a proforma specially designed for the study.

1.3. Results: LVH was seen in 69 percent of patients with CKD, and we discovered that the Left Ventricular Mass Index (LVMI), which reflects LVH, increased with the severity of renal failure, with 17 percent of patients in the Mild CKD category having LVH, compared to 26 percent in the Moderate CKD category and 57 percent in the Severe CKD category.

1.4. Conclusion: The present study shows that patients with CKD have higher LVMI and highe prevalence of LVH, which is more marked in patients with severe CKD. So, these patients should have a thorough cardiovascular evaluation even if there were no symptoms, and efforts should be made to prevent LVH, during the early course of renal insufficiency, since LVH is an independent predictor of survival.

2. Keywords: Chronic Kidney Disease(CKD), Left Ventricular Hypertrophy(LVH),Left Ventricular Mass(LVM), Left Ventricular Mass Index(LVMI),Glomerular Filtration Rate(GFR).

3. Introduction

Chronic Kidney Disease (CKD) is one of the most frequent illnesses that a doctor encounters on a daily basis. Chronic kidney disease affects every area of the life of those who suffer from it, affecting all body systems and resulting in a variety of abnormalities.

Chronic kidney disease is an irreversible, significant, and typically long-term decrease of renal function that results in illness. Infection and cardio-vascular events account for a major part of

increased morbidity and death among the many causes [1,2]. Cardiac disease is the leading cause of mortality among dialysis patients, accounting for 40% of fatalities according to International databases [2, 3, 4].

In chronic kidney disease, Left Ventricular Hypertrophy (LVH) is a common echo-cardiographic finding [4, 5]. The prevalence of LVH rises as renal function declines5. Left ventricular hypertrophy, which is present in around 70% of patients before dialysis begins, is an independent predictor of survival [5, 6, 7].

Early in the course of chronic kidney disease, echocardiography should be performed, and it may be useful in the monitoring of treatment for these individuals3.So this study was done to see the prevalence of LVH by echocardiography in patients with CKD and to find out Correlation of LVH with severity of CKD.

3. Materials and Methods

This was a cross sectional study consisting of 125 chronic kidney disease patients who were enrolled from 2019 to 2021 over a period of 18 months. Patients were recruited from Medical ICU, OPD and Dialysis ward of Nephrology in Department of General Medicine at a tertiary care teaching institution at Chengalpattu District. Institutional ethical committee approval was obtained before the start of the study and informed written consent was obtained from all the patients.

The study population included patients with mild, moderate and severe Chronic Kidney Disease attending the hospital and patients with other cardiac disorders such as valvular heart disease, congenital heart disease and patients with poor echo window were excluded.

Considering the prevalence of Left Ventricular Hypertrophy on Echo in CKD patients as 41% according to Parfrey P S et al2 n=4pq/l2 Where, p is 41%(prevalence of LVH), q is 100-41=59,l is precision error 9%(Absolute) Hence, N = 4*41*59/92 = 12 Thus the total sample size required for the study is 125.

The following set of investigations were asked for the patients included in the study Complete Haemogram ,Renal function tests ,Urine Analysis,Renal Ultrasound Serum Electrolytes, Serum Calcium, Serum Phosphorous ,Chest Skiagram Electrocardiography-12 lead ,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 [8 ,9].

•ThicknessofInterventricularseptum(IVSd),ThicknessofPosterior 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 Echocardiography10.

Left Ventricular Mass (LVM) = 0.8 {[1.04x (LVIDd+IVSd+PWd)3 -LVIDd3]}+0.6

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

Body surface area calculated by Dubois formula

BSA = 0.007184 x Weight0.425 x Height0.725

Left Ventricular Hypertrophy is defined in absolute terms as11.

LVMI – More than 131 g/m2 in men

LVMI – More than 100 g/m2 in women

4. Statistical Methods:

4.1. Descriptive Statistics

1.Numerical variables like Age etc., are represented in mean, median, mode and standard deviation.

2.Categorical variables like gender, stages of CKD etc. are represented in frequencies and percentages. Pie-charts and bar diagrams are used as appropriate.

4.2. Inferential Statistics

3. P-values less than 0.05 were considered statistically significant

4. Data was entered in MS excel sheet and analysed using SPSS software version 16. In the present study, out of the 125 patients with CKD,86 patients (69%) had Left Ventricular Hypertrophy and 39 patients (31%) had no signs of Left Ventricular Hypertrophy.

4.3. Denotes a Significant Difference

The mean blood urea (mg/dl) of individuals with severe, moderate, and mild CKD differed statistically significantly (P0.001).

Patients with severe CKD had a higher mean blood urea level than patients with moderate and mild CKD, with the mean difference between them being statistically significant (P0.001). However, there was no statistically significant difference in mean between individuals with severe and mild CKD (P>0.05).

Patients with severe CKD had higher mean serum creatinine levels, followed by those with moderate and mild CKD. There was a statistically significant difference in mean serum creatinine between the two groups (P0.05).

The mild group had the highest mean Creatinine Clearance (ml/min), followed by the moderate and severe categories. There was a statistically significant difference in mean Creatinine Clearance between the two groups (P0.001). Haemoglobin (gm%) was observed to be lower in patients with severe CKD than in those with mild or moderate CKD. It was discovered that the difference in mean haemoglobin between the mild and severe categories, as well as the moderate and sever categories, was statistically significant (P0.001). The difference in hae-

moglobin between the mild and moderate groups, however, was not statistically significant (P>0.05).

Moderate CKD patients showed greater mean serum potassium (mEq/l), followed by severe and mild CKD patients. However, no statistically significant difference in mean Serum Potassium (P>0.05) was found between any of the groups. Individuals with Severe CKD had lower mean serum calcium (mg/dl), followed by patients with Moderate and Mild CKD. However, there was no statistically significant difference in mean Serum Calcium between any of the groups (P>0.05).

Those with moderate CKD had greater mean serum phosphorus (mg/dl), followed by patients with mild and severe CKD. The difference in mean Serum Phosphorus between the moderate and severe categories was found to be statistically significant (P0.01). However, there was no statistically significant difference between the mild and severe categories, as well as the mild and moderate categories (P>0.05)

There was no statistically significant difference in the severity of CKD levels as a function of age (P>0.05), SBP (P>0.05), or DBP (P>0.05). In the current study, we identified a substantial difference in mean CrCl between those with severe CKD, moderate CKD, and mild CKD (P0.001). Individuals with moderate CKD had a statistically significant difference in mean CKD compared to those with mild CKD (P0.001). Patients with mild CKD had a higher mean CrCl, followed by patients with moderate CKD and severe CKD, with a statistically significant difference in mean CrCl between them.

Patients in the severe CKD group have a higher mean LVIDd than those in the moderate and mild CKD categories, respectively. The difference in mean LVIDd between the severe and moderate categories was statistically significant (P0.05), but not between the mild and moderate categories or between the mild and severe categories (P>0.05). The mean LVPWd values reported across the groups did not differ statistically significantly (P>0.05). Patients with severe CKD had a higher mean LVPWd, while patients with moderate and mild CKD had almost the same.

Patients in the severe CKD category had a greater mean IVSd than those in the mild and moderate CKD categories. The mean difference in IVSd between the severe and moderate categories, as well as the severe and mild categories, was determined to be statistically significant (P0.05). However, the mean difference between the mild and moderate categories was not statistically significant (P>0.05).

There was a statistically significant difference in mean LVM between the severe and moderate CKD groups (P0.01). However, there was no statistically significant difference in mean LVM between severe and mild CKD, as well as mild and moderate CKD (P>0.05). In terms of mean LVMI, there was no statistically significant difference between individuals with mild and severe CKD levels (P>0.05). However, the difference in mean LVMI between the mild and severe categories, as well as between the moderate and severe categories, was shown to be statistically significant (P0.01).

Table 1: Showing Age Distribution

Age(In Years)	Frequency	Percentage
41-50	22	17 %
51-60	38	31 %
61-70	51	41 %
71-80	14	11 %
Total	**125**	**100 %**

Table 2: Showing the Gender Distribution

Gender	Frequency	Percentage
Male	83	67%
Female	42	33%
Total	**125**	**100**

Table 3: Showing etiology of Chronic Kidney Disease

Etiology	Frequency	Percentage
Diabetes + Hypertension	55	44 %
Diabetes Mellitus	49	39 %
Hypertension	17	13 %
APKD	02	02 %
Chronic Glomerulonephritis	01	01 %
Obstructive	01	01 %
Total	**125**	**100%**

Table 4: Showing the distribution of Blood Urea Levels

Blood Urea (mg/dl)	Frequency	Percentage
50 - 100	38	30%
101-150	50	40%
151 -200	32	26%
> 200	5	4%
Total	**125**	**100%**

Table 5: Showing the Distribution of Serum Creatinine

Serum Creatinine (mg/dl	Frequency	Percentage
1.5 - 3	25	20%
3-6	50	40%
>6	50	40%
Total	**125**	**100%**

Table 6: Distribution based on Creatinine Clearance

Stage	No. of Cases	Percentage
Stage 1 Signs of mild disease with normal or better GFR; GFR- >90%	0	0
Stage 2 Mild disease with reduced GFR; GFR 60- 89%	0	0
Stage 3 Moderate; GFR 30- 59%	6	5
Stage 4 Severe; GFR 15-29%	42	33
Stage 5 ESRD; GFR <15%	77	62
Total	**125**	**100**

Table 7: Showing the distribution of the levels of Haemoglobin

Level of Hb% (gm%)	Frequency	Percentage
5.1 - 7.0	24	19%
7.1 - 9.0	62	50%
9.1 - 11	36	29%
> 11	3	2%
Total	**125**	**100%**

Table 8: Showing levels of Serum Potassium

Level of Sr.Potassium mEq/L	Frequency	Percentage
<3	1	1%
3.1 - 4.0	26	21%
4.1 - 5.0	50	40%
5.1 - 7	48	38%
Total	**125**	**100%**

Table 9: Showing levels of Serum Calcium

Levels of Sr.Calcium mg/dl	Frequency	Percentage
6 – 7	11	9%
7.1 - 8.0	26	21%
8.1 – 9	48	38%
9.1 – 10	26	21%
10.1 – 11	13	10%
> 11	1	1%
Total	**125**	**100%**

Table 10: Showing levels of Serum Phosphorus

Levels of Sr.Phosphorus mg/dl	Frequency	Percentage
02-Apr	24	19%
4.1 - 5.0	58	46%
5.1 - 6	34	27%
6.1 - 7	7	6%
> 7	2	2%
Total	**125**	**100%**

Table 11: Showing the Electrocardiographic Changes

Particulars	Frequency	Percentage
LVH	86	69%
NO LVH	39	31%
Total	**125**	**100%**

Table 12: Showing Echocardiographic Changes

Echo Changes	Frequency	Percentage
NO LVH	39	31%
LVH	86	69%
Total	**125**	**100%**

Table 13: Demonstrating worsening of renal disease with presence or absence of LVH on Echocardiography

Severity Of CKD	LVH	Percentage	NO LVH	Percentage
Mild	15	17%	11	29%
Moderate	22	26%	21	55%
Severe	49	57%	7	16%
Total	**86**	**100%**	**39**	**100%**

Table 14: Analysis of biochemical parameters according to severity of CKD

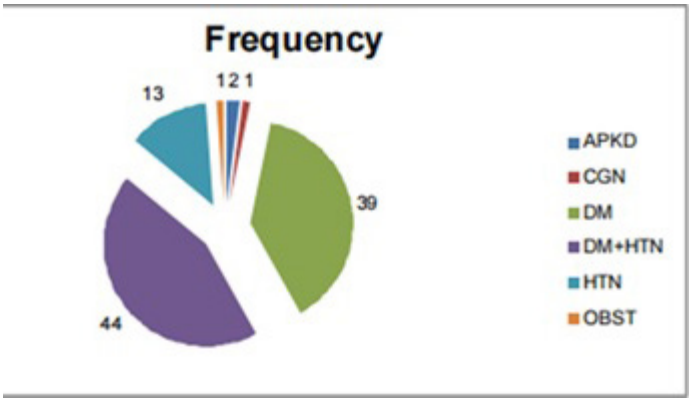
Parameter	Severe [a]	Moderate [b]	Mild [c]	P-Value
Age (yrs.)	59.25±10.18	60.18±7.76	63.05±7.59	
Blood Urea (mg/dl)	159.15±36.30	104.03±38.00f	91.24±35.70	a vs b <0.001* a vs c <0.001* b vs c >0.05
Serum Creatinine (mg/dl)	10.13±3.90	4.21±0.78	2.35±0.38	a vs b <0.001* a vs c <0.001* b vs c <0.05*
Creatinine 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*
Haemoglobin (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 a vs c >0.05 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

Table 15: Analysis based on Creatinine Clearance

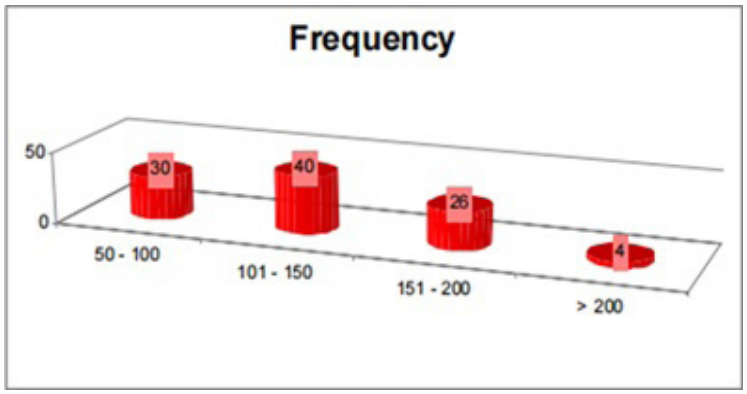
Parameter	Severe (a)	Moderate (b)	Mild (d)	P-Value
				a vs b <0.001
				a vs c <0.001
Cr Cl	7.90±2.94	14.93±2.34	25.81±9.18	b vs c <0.001

Table 16: Analysis based on etiology with the severity of CKD

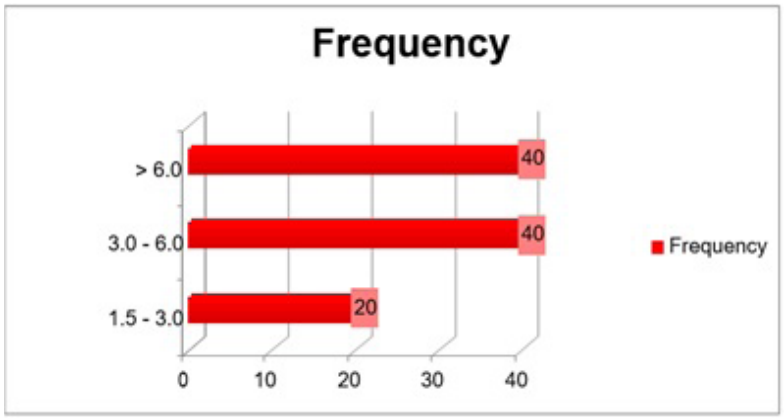
	Severity of CKD			
Etiology	**Severe**	**Moderate**	**Mild**	**Total**
APKD	2	0	0	2
CGN	0	0	1	1
DM	18	20	10	48
DM+HTN	27	20	9	56
HTN	9	3	5	17
OBST	0	0	1	1
Total	**56**	**43**	**26**	**125**



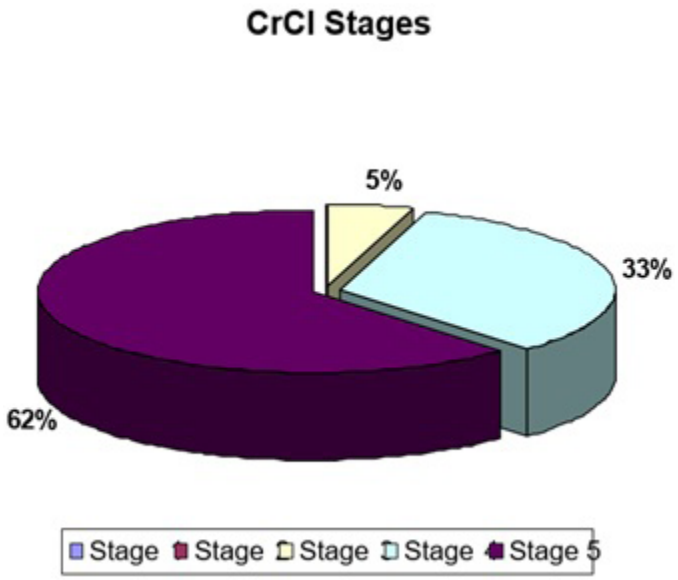
Graph 1: Etiology of Chronic Kidney Disease



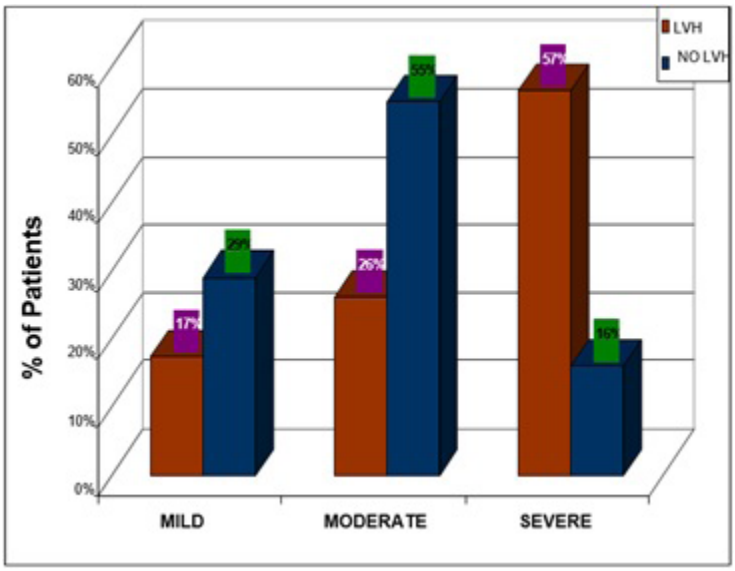
Graph 2: Showing the distribution of Blood Urea Levels



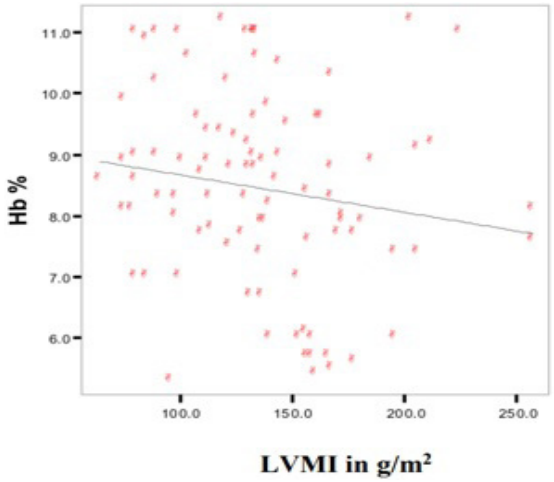
Graph 3: Showing the distribution of Serum Creatinine



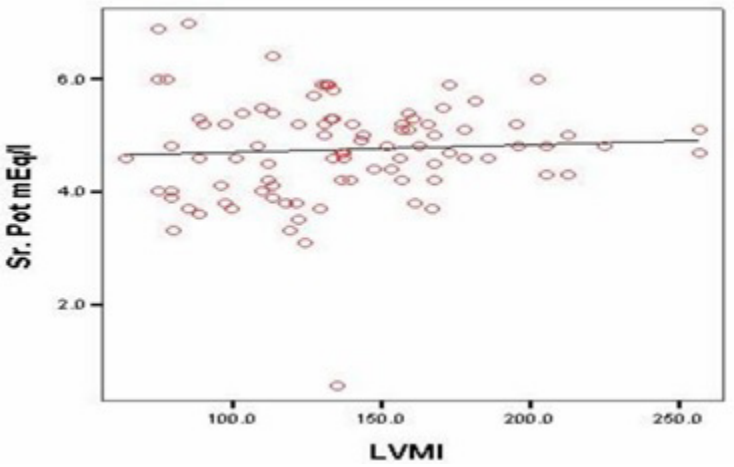
Graph 4: Showing the distribution based on Creatinine Clearance



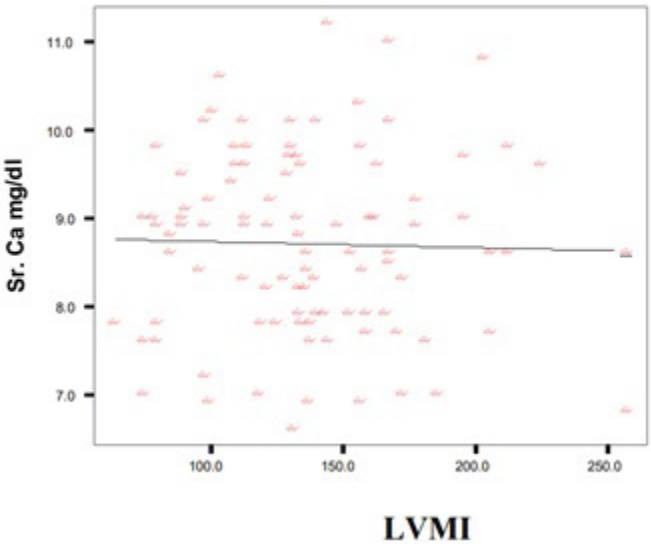
Graph 5: Graph showing the distribution of patients based on severity of Chronic Kidney Disease with Echo changes



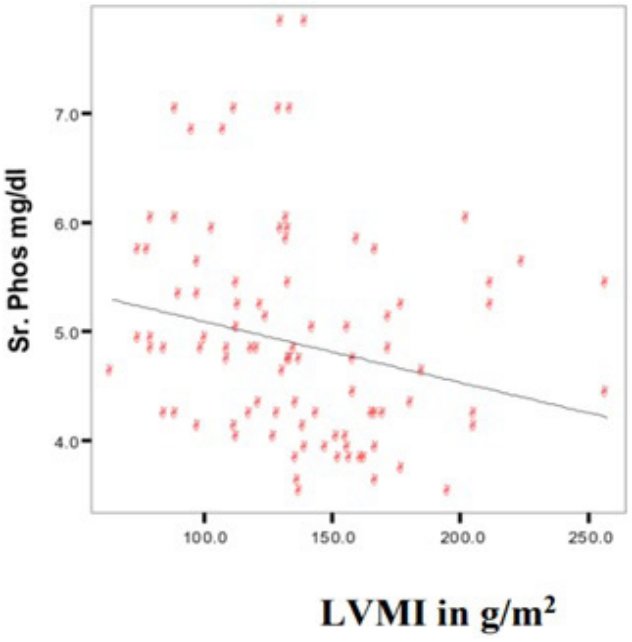
Graph 6: Showing the Correlation between LVMI and the Hemoglobin levels



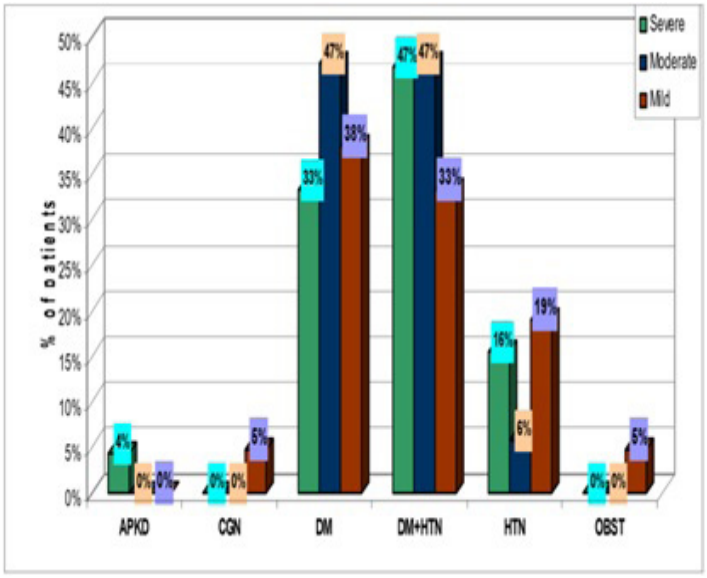
Graph 7: Showing the Correlation between LVMI and Serum Potassium levels



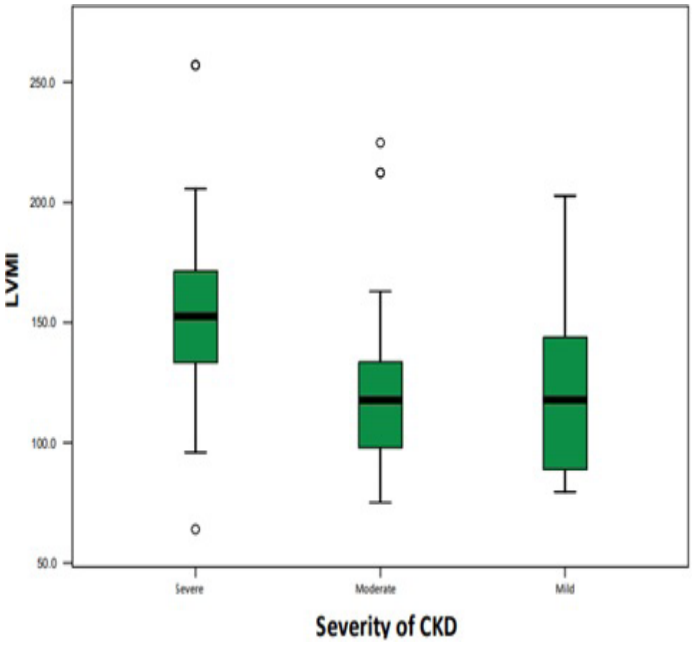
Graph 8: Showing the Correlation between LVMI and Serum Calcium levels



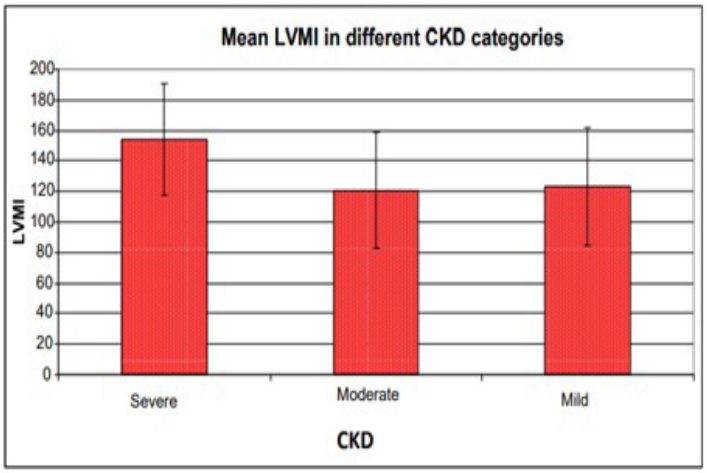
Graph 9: Showing the Correlation between LVMI and Serum Phosphorus levels



Graph 10: Graph showing the distribution of etiology based on severity of CKD



Graph 11: Box Plot of LVMI in the three categories of CKD Group



Graph 12: Graph showing the distribution of LVMI in various grades of CKD

5. Discussion

The study was done at a tertiary care teaching institution in Chengalapttu district among CKD patients of different age groups satisfying the eligibilty criteria over a period of 18 months with the main objective of studying the prevalence of LVH by Echo in patients with CKD of different age groups and to find out correlation of LVH with severity of CKD

In this investigation, we discovered that LVMI increased in tandem with the degree of renal failure. , this is in line with the findings of [12, 13, 14], who discovered a similar LVMI tendency in CKD patients.

The link between the existence of LVH and various stages of CKD has been reported. The current study found a linear relationship between ageing and gradual deterioration in renal function, which is consistent with previous research. Based on events that CKD risk factors such as diabetes mellitus and hypertension are increasing with ageing, we discovered that the prevalence of LVH was increasing with ageing among CKD patients, largely due to increased risk factors for LVH with age (P =0.001), which is similar [15] study.

We also discovered that the overall prevalence of LVH in patients with CKD was 69.0 percent, and that the prevalence of LVH increased with progressive decline in renal function (P = 0.005), which is similar to Aktas Yilmaz et al16. study, which found that the prevalence of LVH in CKD was detected in 67.6 percent of patients with CKD stages 3 and 4 at the baseline, and increased to 89.7 percent in one year in Turkey.

However, [17] reported an unusually high prevalence of LVH in CKD patients, with an LVH prevalence of 87.0 percent. The reasons for this could be due to suboptimal medical treatment of the studied patient population and different age groups with different risk factors such as haemoglobin, blood pressure, and proteinuria levels.

Another study from Pakistan found that 56.3 percent of CKD patients had LVH18. The lower prevalence of LVH in their study could be attributable to the removal of patients with high blood pressure, and the average age of their patients was 42 years.

In a randomised controlled trial, Richard J. et al19found that as CKD advances, the prevalence of LVH rises, and that by stage 5 CKD, prior to starting renal replacement treatment, roughly 70–90% of patients have LVH of varied degrees of severity20. There was a clear link between declining renal function and rising LVMI, with the link being stronger at lower renal function levels.

6.Strengths

There is no role for interobserver bias as the data is primarily collected by the principal investigator. The parameters measured in the study were mostly lab parameters and there is no role for observer bias and subject bias.

6.1. Limitations

The study was conducted in a Hospital based tertiary care setting, where the standard of care is high, and the results cannot be generalised to other settings.

6.2. Recommendations

This study demonstrates the high prevalence of LVH in patients with renal insufficiency prior to the need for dialysis, which is associated with severity of renal impairment, and identify modifiable factors (systolic blood pressure, anaemia etc..) as important predictors of LVH.Further studies in future should focus on interventions aimed attenuating the impact of these factors.

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