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Original Research Article

Echocardiographic assessment of left ventricular hypertrophy in patients of chronic kidney disease

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ABSTRACT

Background: Present study was conducted with an objective to study the prevalence of left ventricular hyper trophy (LVH) by echocardiography in patients with chronic kidney disease (CKD) and to find out correlation of left ventricular hypertrophy with severity of chronic kidney disease.
Methods: From November 2012 to September 2014, 100 chronic kidney disease patients who were admitted in hospital or attended on OPD basis for dialysis were taken for study. Detailed history, clinical evaluation, laboratory investigations and echocardiography was carried out. The diagnosis of CKD was made on basis of serum creatinine more than 1.5 mg/dl which remained constantly for more than 3 months. Patients with mild, moderate and severe CKD were having serum creatinine level 1.5-3mg/dl, 3-6mg/dl and > 6mg/dl respectively. Glomerular filtration rate (GFR) was calculated by modification of diet in renal disease (MDRD) equation. Cut-off for CKD was taken to be <60ml/min / 1.73m2 as per existing guidelines.
Results: Out of 100 patients studied, 67 were males and 33 were females. All patients were selected randomly. Majority of the patients were in the age group of 61 -70 years (41%). In the present study, it was found that left ventricular mass index (LVMI) which reflects LVH showed a progressive rise in severity of renal failure with 17 % of mild category of CKD having LVH as compared to 26% of moderate category and 57% of severe category of CKD.
Conclusions: Patients with CKD have 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, such as strict control of hypertension, anaemia.

Keywords: Chronic kidney disease, Glomerular filtration rate, Left ventricular hypertrophy, Left ventricular mass index

INTRODUCTION

Chronic kidney disease (CKD) encompasses a spectrum of different pathophysiologic processes associated with abnormal kidney function and a progressive decline in glomerular filteration rate (GFR).[1] Chronic kidney disease, (previously known as chronic renal failure) is defined as irreversible, substantial and usually long standing loss of renal function causing ill health.[2] Among various causes, infection and cardiovascular events contribute towards large proportion of increased morbility and mortality. Cardiac disease is the major cause of death in dialysis population accounting for 40% of death in international registries. In 1997, annual report of US Renal Data System (US RDS) revealed that morbidity in patients with CKD is attributed mainly to cardiac causes (49%).

Left ventricular hypertrophy (LVH) is a major echocardiographic finding in kidney disease.[3-5] Prevalence of LVH increases with decline of renal function.[6] Left ventricular hypertrophy, an independent

predictor of survival, present approximately 70% of patients at the initiation of dialysis. There is scanty information on the prevalence of left ventricular hypertrophy and nature of LVH in patients with CKD. Objective of the present study was to estimate the prevalence of LVH by echocardiography in patients with CKD and to find out correlation of LVH with severity of CKD.

METHODS

The present study was conducted from November 2012 to September 2014 in the department of General Medicine, M.K.C.G. Medical College Hospital, Berhampur, Odisha, India. Descriptive study was design, with a sample size of 100. The work was carried out after approval from the Institutional Ethics Committee of M.K.C.G. Medical College Hospital, Berhampur, Odisha. The data for this study was collected from 100 CKD patients fulfilling the inclusion /exclusion criteria admitted in M.K.C.G. Medical College Hospital, Berhampur and patients on dialysis attending on OPD basis using a proforma specially designed for the study.

Statistical analysis

Descriptive statistical analysis of data like frequency and percentages were used for categorical variables. Mean and standard deviation were used for describing continuous variables. Inferential statistical tools like chi-square test and student's t-test were used. P-value of <0.05 was considered statistically significant.

Inclusion criteria

Patients with mild, moderate and severe chronic kidney disease attending the hospital and patients on dialysis.

- Mild CKD patients with serum creatinine (1.5-3mg/dl),
- Moderate CKD patients with serum creatinine (3-6mg/dl),
- Severe CKD patients with serum creatinine (>6mg/dl).

Underlying causes of CKD include diabetic nephropathy, hypertensive nephropathy, chronic glomerulonephritis, chronic tubulointerstitial disease, autosomal dominant polycystic kidney disease.

Exclusion criteria

- Patients with other cardiac disorders, such as valvular heart disease, congenital heart disease,
- Patients with poor echo window methods of sample collection.

Investigations

- Complete hemogram,
- Renal function test,
- Liver function test,
- Urine analysis and culture,
- Renal ultrasound,
- Lipid profile,
- Serum electrolytes, serum calcium, serum phosphorous,
- Chest skiagram,
- Electrocardiography-12 lead,
- 2D Echocardiography.

All patients underwent 2-dimensional directed M-mode echocardiography performed in left lateral position. The following measurements were taken into account by Penn convention methods.[2,6,7]

- Thickness of interventricular 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 recommented by American Society of Echocardiography.[2,6,7]

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

Left ventricular mass Index (LVMI)= LVM/Body surface area.

Body surface area calculated by Du Bois formula:

BSA=0.007184xW^0.425xH^0.725

W=weight in kilograms (kgs),
H=height in centimeters (cms),
Left ventricular hypertrophy is defined in absolute terms:
LVMI=more than 131g/m^2 in men,
LVMI=more than 100g/m^2 in women.

Creatinine clearance (Crcl) was calculated according to the formula derived from Cockcroft-Gault equation:

Crcl = {140-age(years)} x weight (kgs) for males/Plasma creatinine x 72

Crcl = {140-age (years)} x weight (kgs) for females/Plasma creatinine x 72 x 0.85

Normal values of creatinine clearance

- In men 90-139ml/min
- In women 80-135ml/min.[2,6,7]

RESULTS

Out of 100 patients studied, with an age group of 41 to 80 years, 67% were males and 33% were females.

In the present study, combined diabetes and hypertension was the leading cause of chronic kidney disease (44%), followed by diabetes (39%). Hypertension 13%, adult polycystic kidney disease 2%, chronic glomerulonephritis 1% and obstructive pathology 1% respectively.

The range of serum urea level in the present study was between 50-285mg/dl. The range of serum creatinine level between 1.5-20.8mg/dl. 80% were equally distributed in moderate and severe CKD group (40% each) and remaining 20% in the mild CKD group Crcl <15% was seen in 62% of patients and crcl between 15-29% was seen in 33% patients.

Out of 100 patients with CKD, 69 patients (69%) had left ventricular hypertrophy and 31 patients (31%) had no signs of left-ventricular hypertrophy.

It was observed that a significant difference was found in mean creatinine clearance between patients with severe CKD and moderate CKD as well as mild CKD ($p<0.001$).

Higher mean creatinine clearance was found in patients with mild CKD followed by moderate and severe CKD respectively.

Higher mean LVIDd was recorded in patients belonging to severe CKD category followed by moderate and mild CKD category. The difference in mean LVIDd between severe and moderate category was found to be statistically significant. ($p<0.05$), but not significant between mild and severe category ($p>0.05$).

Table 1: Age distribution of 100 cases of chronic kidney disease.

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

Table shows, the age variation was from 41 to 80 years. Majority of patients were in the age group of 61-70 years that included 41 patients (41%).

Table 2: Gender distribution.

Gender	Frequency	%
Female	33	33
Male	67	67
Total	100	100

Table 2 shows, the present study group consisted of 67% males and 33% females.

No statistically significant difference was observed in the mean LVpWd values recorded between the groups (p.0.05).

The mean IVSd was found to be higher in patients belonging to severe CKD category followed by mild and moderate CKD categories.

Statistically significant difference was present between severe and moderate as well as severe and mild categories.

The difference in mean LVM, LVMI between severe and moderate CKD category was found to be statistically significant (p.0.01), but the difference in mean LVM, LVMI between severe, mild and moderate CKD categories was not statistically significant (p.0.05).

Table 3: Etiology of chronic kidney disease.

Etiology of chronic kidney disease	Frequency	%
Diabetes + hypertension	44	44
Diabetes mellitus	39	39
Hypertension	13	13
APKD	2	2
Chronic glomerulonephritis	1	1
Obstructive	1	1
Total	100	100

Table 3 shows, combined diabetes and hypertension was the leading cause of chronic kidney disease in 44 patients (44%), followed by diabetes in 39 patients (39%), hypertension in 13 patients (13%), adult polycystic kidney disease (APKD) in 2 patients (2%), chronic glomerulonephritis in 1 patient (1%) and obstructive pathology in 1 patient (1%) respectively.

Table 4: Distribution of serum urea levels in CKD.

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

Table 5: distribution of serum creatinine levels in CKD.

Level of serum creatinine (mg/dl)	Frequency	%
1.5-3 (mild CKD)	20	20
3-6 (moderate CKD)	40	40
>6 (severe CKD)	40	40
Total	100	100

Table 4 shows, serum urea level was between 50-280mg/dl. Maximum number of patients i.e., 40 patients (40%) had serum urea in the range of 101-150mg/dl, followed by 30 patients (30%) had serum urea in the range of 50-100mg/dl.

Table 5 shows, the range of serum creatinine level was between 1.5 to20.8mg/dl. However, 80 patients (80%) were equally distributed in moderate and severe CKD group (i.e., 40% in each group) and remaining 20% were in the mild CKD group.

Table 6: Distribution based on creatinine clearance in CKD.

	Stage	No. of cases	%
Stage1	(signs of mild kidney disease with normal or better GFR; GFR>90%)	0	0
Stage2	(mild kidney disease with reduced GFR, GFR60-89%)	0	0
Stage3	(moderate chronic renal insufficiency; GFR 30-59%	5	5
Stage4	(severe chronic renal insufficiency; GFR 15-29%	33	33
Stage5	(end stage renal disease; GFR <15%)	62	62
	Total	100	100

Table 6 shows, CrCl <15% was seen in 62% of patients and CrCl between 15-29% was seen in 33% of patients.

Table 7: Distribution of the levels of haemoglobin.

Level of Hb % (gm%)	Frequency	%
5.1-7.0	19	19
7.1-9.0	50	50
9.1-11.0	29	29
>11.0	2	2
Total	100	100

Table 7 shows, majority of the patients, 50 patients (50%) had hemoglobin levels between 7.1-9 gm%, followed by 29 patients (29%) in between 9.1-11gm%.

Table 8: Levels of serum potassium.

Level of sr. Potassium mEq/L	Frequency	%
<3	1	1
3.1-4.0	21	21
4.1-5.0	40	40
5.1-7.0	38	38
Total	100	100

Table 8 shows, the range of serum potassium was 2.9-7 mEq/L. In this 40% of patients had serum potassium level between 4.1-5 mEq/L and 1% had levels <3%.

Table 9: Levels of serum calcium.

Levels of sr. calcium mg/dl	Frequency	%
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

Table 9 shows, the range of serum calcium levels was from 6-11.2mg/dl. In 38 patients (38%) serum calcium levels were between 8.1-9mg/dl.

Table 10: Levels of serum phosphorus.

Levels of sr. phosphorus mg/dl	Frequency	%
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

Table 11: Electrocardiographic changes.

Particular	Frequency	%
LVH	69	69
No LVH	31	31
Total	100	100

Table 12: Echocardiographic changes.

Echo changes	Frequency	%
No LVH	31	31
LVH	69	69
Total	100	100

Table 13: Data comparing with severity of CKD with presence of LVH or not on echo.

Severity of CKD	LVH	%	No LVH	%
Mild CKD	12	17%	9	29
Moderate CKD	18	26%	17	55
Severe CKD	39	57%	5	16
Total	69	100%	31	100

Table 10 shows, the range of serum phosphorus was between 2.9-7.4 mg/dl. In 46 patients (46%) the serum phosphorus levels were between 4.1-5mg/dl. Table 11 shows, Electrocardiographic abnormalities i.e., left ventricular hypertrophy was seen in 69 patients (69%).

Table 12 shows, out of 100 patients with CKD, 69 patients (69%) had left ventricular hypertrophy and 31 patients (31%) had no signs of left ventricular hypertrophy. Table 13 shows, LVH was present in 57%, 26% and 17% in cases of severe, moderate and mild CKD respectively. Table 14 shows, that a significant difference in mean creatinine clearance between patients with severe CKD and moderate CKD as well as mild CKD ($p<0.001$).

Table 14: Analysis based on creatinine clearance.

Parameter	Severe (a)	Moderate (b)	Mild (c)	P-value
Cr clearance	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

DISCUSSION

Premature cardiovascular disease is a significant cause of morbidity and mortality among patients with CKD. Four main structural abnormalities of the heart have been described in patients with CKD, LV hypertrophy, expansion of the nonvascular cardiac interstitium leading to inter myocardiocytic fibrosis, changes in vascular architecture, and myocardial calcification. All these promote systolic as well as diastolic dysfunction which leads to symptomatic heart failure, which is a risk factor for premature death.

Echocardiography provides an excellent noninvasive method to delineate details of the anatomy of cardiac cavity, wall dimensions and wall movements.LV hypertrophy is single strongest independent predictor of adverse cardiovascular events. LVH is a major echo cardiographic finding in uremic patients.

In the present study, it was found that LVMI showed a progressive rise with increase in severity of renal failure. This is in concordance with the study done by Dangiri P et al, Agarwal S et al Adeera Levin et al who also found similar trend of LVMI in patients of CKD.[2,6,8]

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 al (70%), as compared to other studies done by Yashpal et al (15.49%) Chafekar DS et al (17.6%) Parfrey PS et al (41%).[8-11]

Of the 69% of patients with LVH,12 (17.39%) patients were from mild CKD category, 18 (26%) patients were from moderate CKD category and 39 (56.52%) patients were from severe CKD category respectively as compared to 40% of mild and moderate and 97% in severe CKD category as shown by Dangiri P et al and 30% in mild to moderate category and 53.2% in severe category as shown by Agarwal S et al.

CONCLUSION

From the above discussion it is concluded that patients with chronic kidney disease have higher left ventricular mass index (LVMI)and higher prevalence of left ventricular hypertrophy (LVH), and also with respect to category of chronic kidney disease, the LVH prevalence progressively increases with increasing severity of chronic kidney disease.

The high prevalence of left ventricular hypertrophy 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 left ventricular hypertrophy should be started early during the course of renal-insufficiency, such as effective control of hypertension, anemia.

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