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Left Ventricular Functions in Patients with Chronic Kidney Disease

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Abstract: ***Introduction: Chronic kidney disease (CKD) encompasses a spectrum of pathophysiological process associated with abnormal kidney function and a progressive decline in glomerular filtration rate[1]. It is a global health concern. CKD has been the 12th leading cause of mortality and 17th leading cause of disability[2]. Leading categories of etiologies for CKD are diabetic nephropathy, glomerulonephritis and hypertension. Most patients with CKD succumb to cardiovascular disease before ever reaching stage 5 CKD. A large cohort study of patients with CKD stages 2 to 4 showed that death was seen more often than progression to kidney failure in all stages of CKD. Hence most patients in the earlier stages of CKD do not progress to kidney failure because of mortality caused due to cardiovascular disease. Materials and method: This was a cross sectional study carried out with 100 patients who were already diagnosed to have Chronic Kidney Disease. Cardiac function was assessed using echocardiography and left ventricular function in the form of left ventricular ejection fraction was measured. It was compared among different stages of CKD. Results: The study documented a significant reduction in the left ventricular function in patients with CKD, It was observed that 60% had systolic dysfunction with left ventricular ejection fraction less than 50%. Conclusion: This study was mainly undertaken to study Echocardiographic changes in CKD patients. This study had shown that left ventricular hypertrophy was present in significant number of patients with Chronic Kidney Disease. This study also showed that LV systolic dysfunction was significant in CKD patients. Regular Echocardiographic evaluation of CKD patients forms an important tool in early identification and prevention of cardiovascular complications associated with Chronic Kidney Disease.***

Keywords: Chronic Kidney Disease; Diabetes Mellitus; Left Ventricular Hypertrophy; Diastolic Dysfunction; Echocardiography

1. Introduction

Chronic kidney disease (CKD) encompasses a spectrum of pathophysiological process that is associated with abnormal kidney function and a progressive decrease in Glomerular Filtration Rate (GFR).1 It refers to functional or structural abnormalities of kidneys for more than three months, irrespective of cause. It is a global health concern. CKD has been the 12th leading cause of death, and the 17th leading cause of disability[2]. CKD is associated with many other co - morbidities and therefore CKD is a disease with high mortality[2]. An analysis of risk factors for development and progression of CKD is necessary in clinical practice.

Chronic Kidney Disease is associated with higher incidence of cardiovascular events. Cardiovascular events are one of the important causes of morbidity and mortality in all the stage of CKD. Most of the patients with CKD develop cardiovascular complications before reaching ESRD. The CKD registry[5] has shown that patients with CKD stage 4 have a higher incidence of cardiovascular complications. Most of the patients die before they reach ESRD (CKD stage 5). Patients in early stages of CKD are also found to have a high cardiovascular morbidity. Hence we should look into the prevention of cardiovascular complications.

Heart and kidneys are linked to each other in the hemodynamic and regulatory functions. There are multiple communications among these two organs like Sympathetic Nervous System, Anti Diuretic Hormone, Renin Angiotensin Aldosterone System and natriuretic peptides[4]. National Kidney Foundation formed a Task Force which considered Coronary Artery Disease (CAD) and left ventricular hypertrophy (LVH) as the target conditions, has given recommendations for decreasing cardiovascular mortality in ESRD.[5]

LVH is associated with both systolic and diastolic dysfunction. Findings suggest that mild reduction in the renal perfusion which is caused by the slightly impaired LV systolic function, is associated with pathological, highly pulsatile perfusion in the microvasculature of the kidney. This might be the mechanism for progressive reduction of renal function in patients with pre - existing renal damage. This renal insufficiency produced, adversely affects the function of the heart, which produces a vicious cycle where the renal failure further impairs cardiac performance.

Diastolic dysfunction is associated with higher incidence of episodes of intradialytic hypotension and higher peri - operative death from pulmonary edema at the time of renal transplantation. It is important to recognize and correct the cardiovascular complications.

Echocardiography will provide a very simple and non - invasive assessment of the structure and function of the heart. It also helps us to identify the people who are at greater risk. Strategies to prevent the development and progression of LV dysfunction at an early stage may prove beneficial.

2. Materials and Methods

Study design

This was a cross sectional study carried out with 100 patients who were already diagnosed to have Chronic Kidney Disease. Cardiac function was assessed using echocardiography and left ventricular function in the form of left ventricular ejection fraction was measured. It was compared among different stages of CKD.

Inclusion criteria:

1) Random cases with CKD without considering the etiology.
2) Patients with chronic kidney disease on dialysis.

3) Established cases of CKD (modified kidney disease improving global outcome classification)

Exclusion criteria:

1) Age less than 18 years
2) Patients with history and clinical features suggestive of pre existing cardiac diseases like Rheumatic heart disease, congenital heart disease, cardiomyopathy and pericardial diseases.

3. Methodology

This was a cross sectional study including 100 patients with chronic kidney disease fulfilling inclusion criteria. The selected patients were underwent thorough clinical examination and routine investigations. Echocardiography was done to assess the left ventricular function in the form of left ventricular ejection fraction, and value less than 50% was considered left ventricular systolic dysfunction. It was compared among different stages of CKD.

4. Results

Study included 100 patients with diagnosis of Chronic Kidney Disease.

Mean age of the population was 49.84 years, in that 68 were male and 32 were female patients.

About 81% among the study group had CKD stage 5 (eGFR< 15 ml/min/1.73 $m^{2)}$ and 17% had CKD stage 4. Among the study group 63 % had Left Ventricular Hypertrophy by Echocardiographic assessment. Left ventricular ejection fraction was more than 50 % in 60 subjects. Diastolic dysfunction was found to be 76% among the study population. About 83.9% subjects in CKD stage 5 had LV diastolic dysfunction and about 88% with CKD stage 4 had LV diastolic dysfunction, which is statistically significant. In a study conducted by Behera et al, 17% of the patients with left ventricular hypertrophy had mild CKD, 26% had moderate CKD, and 57% had severe CKD.[13]

Table: studies of various parameters studied

Parameters	Stages of CKD			F value	P value
	Stage 3 (2)	Stage 4 (17)	Stage 5 (81)		
Age	45.00±1.41	59.70±15.99	57.07±13.95	0.99	0.37
S. Creatinine (mg/dl)	1.75±0.07	3.22±0.38	7.31±3.34	15.24	<0.00001
Egfr	42.40±2.26	19.83±3.22	8.51±3.48	161.62	<0.00001
RBS	160.00±12.72	210.41±117.33	189.70±50.90	0.92	0.39
Systolic blood pressure (mm of Hg)	115.00±21.21	132.94±20.82	149.80±26.59	4.53	0.01
Diastolic blood pressure (mm of Hg)	75.00±9.89	82.35±12.75	87.53±14.01	1.69	0.12
Hb %	8.95±0.35	8.62±0.86	8.33±1.35	0.55	0.57
LVEF	60.00±11.31	49.64±6.25	46.27±9.06	3.28	0.04
Diastolic dysfunction	66.6 %	88.2%	83.9%		0.006

5. Discussion

CKD is a global public health problem. Many epidemiological studies have shown that moderate reduction in renal function is associated with increased cardiovascular complications, and that level of kidney function is an independent predictor of cardiovascular outcome.[7]

The kidneys are one of the most highly differentiated organs in the Body[8].

The cardiovascular manifestation in CKD includes[9]

- Left ventricular hypertrophy
- Heart failure: LV diastolic and systolic dysfunction
- Ischemic heart disease – myocardial infarction and angina
- Dilated cardiomyopathy.

Half of the people in the United States are expected to develop CKD during their lifetime [10]. Diabetes and hypertension account for 40–60% cases of CKD[11].

Studies shows along with traditional risk factors like age, gender, ethnicity etc other risk factors secondary to CKD such as anaemia, hyperparathyroidism, proteinuria, activated renin angiotensin system contribute to cardiovascular complications. Heart failure, myocardial infarction, peripheral vascular disease, stroke are common in end stage renal disease.

Cardiac structure and functions can be assessed using various modalities such as electrocardiography, echocardiography, computed tomography and magnetic resonance imaging.

Echocardiography forms simple and non invasive modality which helps in assessment of left ventricular mass, systolic function, Ejection fraction, diastolic function among various other cardiac functions. The aim of this study is to assess echocardiographic changes In a cohort of CKD patients.

The mean age of the study population is 49.84 years.

Minimum age was 24 years and maximum age was 85 years.

About 30% of the study population were in age group between 51 to 60 years.25% were between 61 to 70 years. In a study conducted by Singal et al about 26.7% of the cases were aged between 51 to 60 years.1[2]

In this study, 68% were males and 32% were females. A study conducted by Behera et al had shown that, 67% of the study population were males [13]

The etiology of CKD was hypertension with diabetes mellitus in 44% of the study population.

CKD was found in 32% in diabetics and 15% in hypertensive individuals. Polycystic kidney disease as the cause of CKD in 3% among the study population.

The mean serum Creatinine was 1.75 ± 0.07 mg/dL in stage 3 CKD, about 3.22±038 mg/dL In CKD Stage 4 and was about 7.31±3.34 mg/dL in CKD stage 5.

About 81% among the study group had CKD stage 5 (eGFR< 15 ml/min/1.73 $m^{2)}$ and 17% had CKD stage 4 (eGFR of 15 - 29 ml/min/1.73$m^{2)}$. CKD stage 3 (eGFR 30 - 59 ml/min/1.73$m^{2)}$ was found in 2% in the study population. In a study by Behera et al, about 62% of the cases had CKD stage 5 and 33% had stage 4 CKD.1[3]

Among the study population 62% had heamoglobin levels between 7.1 to 9.0 g/dL, 23% had Hb levels between 9.1 to 11 g/dL. Hb level less than 7 g/dL was found in 11% among the study group. In a study by Shyam Kumar et al, mean heamoglobin was 7.89 g/dL. About 60% had Hb of less than 10 g/dL and 40% of the cases had Hb levels of more than equal to 10 g/dL [14]

Left ventricular hypertrophy was seen in 50% of study population using Electrocardiogram.

Left axis deviation was found in 5% among study population, followed by left bundle branch block.2 patients had both left ventricular hypertrophy and left axis deviation on ECG.

Right bundle branch was seen in 1% among study group. In a study by Rao et al, about 69% of the cases had left ventricular hypertrophy both by electrocardiogram and echocardiogram.

Among the study group 63 % had Left Ventricular Hypertrophy by Echocardiographic assessment. Left ventricular ejection fraction was more than 50 % in 60 subjects. Diastolic dysfunction was found to be 76% among the study population. About 83.9% subjects in CKD stage 5 had LV diastolic dysfunction and about 88% with CKD stage 4 had LV diastolic dysfunction, which is statistically significant. In a study conducted by Behera et al, 17% of the patients with left ventricular hypertrophy had mild CKD, 26% had moderate CKD, and 57% had severe CKD.1[3]

6. Conclusion

This study was undertaken to study the Echocardiographic changes in patients with Chronic Kidney Disease. This study has shown that, left ventricular hypertrophy, left ventricular systolic dysfunction and left ventricular diastolic dysfunction is present in significant number in CKD patients. This study has also showed, most common etiology for CKD is Diabetes Mellitus and Hypertension. This was a single centre study which may preclude to generalise the results. But this study was able to highlight the importance of cardiac assessment in each stage of CKD. Further studies in this aspect can bring more facts about early cardiac assessment in patients with Chronic Kidney Disease.

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