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ORIGINAL RESEARCH

Assessment of left ventricular filling pressure and its correlation with severity of chronic kidney disease

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ABSTRACT

Background:Chronic kidney disease (CKD) is a common health problem worldwide. Cardiovascular disease is the most common cause of morbidity and mortality in CKD. In CKD patients, use of Echocardiography can help in establishing a diagnosis of acute decompensated heart failure. Present study was aimed to assessment of left ventricular filling pressure and its correlation with severity of chronic kidney disease. Material and Methods: Present study was single-center, prospective, observational study, conducted patients aged >18 years, either gender, diagnosed cases of CKD as per KIDGO criteria underwent resting 2-D transthoracic echocardiography. Results: In present study, 80 cases of CKD underwent 2-D transthoracic echocardiography evaluation. Majority were from 50-59 years age group (53.75 %), male (66.75 %). In present study majority were from CKD stage 2 (53.75 %) followed by CKD stage 3 (28.75 %), CKD stage 4 (22.5 %) & CKD stage 5 (13.75 %). Among study patients, 45 patients (56.25 %) had normal LVFP, while 27 patients (33.75 %) had 9-13 LVFP & increase in LVFP (> 13) was noted in 8 patients (10 %). Mean value of LVFP in CKD stage 2 was 8.68 ± 2.15, mean LVFP in CKD stage 3 was 10.34 ± 2.64, mean LVFP in CKD stage 4 was 12.92 ± 3.84 & mean LVFP in CKD stage 5 was 13.46 ± 3.23. We noted statistically significant association between increase in stage of CKD with progressive rise in mean LVFP value. Conclusion: The increase in left ventricular filling pressure is directly proportional to the CKD stage i.e., severity of renal failure.

Keywords: left ventricular filling pressure, CKD stage, diastolic dysfunction, echocardiography

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INTRODUCTION

Chronic kidney disease (CKD) is a common health problem worldwide. Cardiovascular disease is the most common cause of morbidity and mortality in CKD. CKD and heart failure (HF) are both chronic diseases and share many risk factors such as diabetes mellitus,

advanced age, hypertension and coronary artery disease. HF has been found to be almost four times as common relative to patients without CKD.

Over the years, echocardiography has made major advancements in the field of non-invasive diagnostic cardiology. It helps in haemodynamic assessment, detection of mechanical complications, risk stratification and long-term prognosis in cardiac illness patients.[3] Echocardiography offers an easy noninvasive way to assess and follow-up cardiac dysfunction and structural changes.[4]

In CKD patients, use of Echocardiography can help in establishing a diagnosis of acute decompensated heart failure (ADHF) by providing additional information on ventricular systolic function, wall thickness, valve function, chamber volumes and filling pressures. Use of Echocardiography has been recommended in CKD to aid in establishing a diagnosis of ADHF.[5,6] The ratio of transmitral early diastolic velocity (E) to early mitral annulus velocity (e') (E/e' ratio) has been shown to be an accurate method of the LV filling pressure estimation and the best predictor of LV diastolic filling in various cardiac pathologies.[6] Present study was aimed to assessment of left ventricular filling pressure and its correlation with severity of chronic kidney disease.

MATERIAL AND METHODS

Present study was single-center, prospective, observational study, conducted in Department of Cardiology, Deccan College of Medical Sciences Hyderabad Telengana,, India. Study duration was of 2 years (January 2021 to December 2022). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- Patients aged >18 years, either gender, diagnosed cases of CKD as per KIDGO criteria, admitted in IPD or visiting to OPD, willing to participate in present study

Exclusion criteria

- Patients with known valvular heart disease or congenital heart disease (CHD), known coronary artery disease (CAD) or previous myocardial infarction, chronic obstructive or restrictive pulmonary disease,
- Patients with chronic liver disease, poor echo window, connective tissue disorder, HIV, hypothyroidism, hyperthyroidism,
- Patients with in-situ pacemaker or implantable cardioverter defibrillator,
- Patients with cancer, immunosuppressive therapy, hypertrophic cardiomyopathy,
- Patients not willing to participate in study

Study was explained to patients in local language & written consent was taken for participation & study. Demographic details, detailed past/ medical history was obtained along with salient clinical findings were noted. All patients underwent investigations such as complete blood count, random blood sugar, kidney function test, spot urinary protein creatinine ratio/24-hour urinary protein & ECG. Based on the serum creatinine levels, patients were divided into five groups depending on their estimated glomerular filtration rate (eGFR) calculated by the Modification of Diet in Renal Disease Study equation.

All patients underwent resting 2-D transthoracic echocardiography and were evaluated for LV end-diastolic, systolic dimensions and end-diastolic and systolic wall thickness of the interventricular septum and LV wall, using standard echocardiographic measurements. Echocardiographic quantification of LVFP is based on the E/e' ratio, where E is the early mitral flow velocity on transmitral Doppler and e' is the early mitral annulus velocity obtained from tissue Doppler. An E/e' ratio <8 is considered to be normal, whereas a ratio >13 was considered as increase in LVFP.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the

continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi-square test or Fisher exact test as applicable. P value less than 0.05 was considered as statistically significant.

RESULTS

In present study, 80 cases of CKD underwent 2-D transthoracic echocardiography evaluation. Majority were from 50-59 years age group (53.75 %), male (66.75 %). In present study majority were from CKD stage 2 (53.75 %) followed by CKD stage 3 (28.75 %), CKD stage 4 (22.5 %) & CKD stage 5 (13.75 %).

Table 1: General characteristics

	No. of patients	**Percentage**
Age groups (in years)		
30-39	0	0
40-49	11	13.75
50-59	43	53.75
60-69	24	30
70-79	2	2.5
Mean age (mean ± SD)	63.23 ± 13.9	
Gender		
Male	53	66.25
Female	27	33.75
CKD Stages		
Stage 1	0	0
Stage 2	28	35
Stage 3	23	28.75
Stage 4	18	22.5
Stage 5	11	13.75

Among study patients, 45 patients (56.25 %) had normal LVFP, while 27 patients (33.75 %) had 9-13 LVFP & increase in LVFP (> 13) was noted in 8 patients (10 %).

Table 2: Left ventricular filling pressure (LVFP) with CKD stage

LVFP	**CKD stage**					**Total (n=80)**
	1	**2 (n=28)**	**3 (n=23)**	**4 (n=18)**	**5 (n=11)**	
≤8	0	20 (71.43 %)	14 (60.87 %)	9 (50 %)	2 (18.18 %)	45 (56.25 %)
9-13	0	8 (28.57 %)	8 (34.78 %)	7 (38.89 %)	4 (36.36 %)	27 (33.75 %)
>13	0	0	1 (4.35 %)	2 (11.11 %)	5 (45.45 %)	8 (10 %)

Mean value of LVFP in CKD stage 2 was 8.68 ± 2.15, mean LVFP in CKD stage 3 was 10.34 ± 2.64, mean LVFP in CKD stage 4 was 12.92 ± 3.84 & mean LVFP in CKD stage 5 was 13.46 ± 3.23. We noted statistically significant association between increase in stage of CKD with progressive rise in mean LVFP value.

Table 3: Mean left ventricular filling pressure (LVFP) & stages of CKD

CKD Stages	**GFR Range**	**LVFP**
Stage 1	Signs of mild kidney disease with normal or better GFR; GFR>90%	
Stage 2	Mild kidney disease with reduced GFR, GFR60-89%	8.68 ± 2.15
Stage 3	Moderate chronic renal insufficiency; GFR 30-59%	10.34 ± 2.64
Stage 4	Severe chronic renal insufficiency; GFR 15-29%	12.92 ± 3.84

Stage 5	End stage renal disease; GFR <15%	13.46 ± 3.23

DISCUSSION

Unless treated, CKD may lead to grave consequences; CKD leads to impairment of excretory, metabolic and endocrine functions of the kidney that leads to the development of clinical syndrome of uremia which includes features like anemia, metabolic bone disease, neuropathy, myopathy, endocrine abnormalities, hypertension, dyslipidemia, acidosis susceptibility to infections and various cardiovascular diseases.[7]

The increased mortality risk in this patient population is specifically due to rapidly developing CV complications during the progression of this serious metabolic disorder. This risk increases 2- to 3-fold already in CKD stage 2 according to the National Kidney Foundation – Kidney Disease Outcomes Quality Initiative (NKF KDOQI) classification[8], and even 10- to 100-fold when a patient begins dialysis.[9]

LV failure is a multifactorial process in patients with CKD. It is caused by chronic volume overload, elevated mean arterial pressure, uremia-mediated cardiac myocyte dysregulation, anemia-mediated hypoxemic stress, and impairment in cardiac function by microvascular and macrovascular coronary artery disease.[10] In CKD patient's diastolic dysfunction of left ventricle occurring very often and related with the failure of heart (HF) with high fatality.[11]

Systolic dysfunction of left ventricle is related with the severe coronary artery disease & it is play a factor for further progression of disease.[12] Proposed pathophysiology of LV dysfunction in CKD suggest that increased preload due to fluid overload, LV hypertrophy, myocardial fibrosis, microvascular abnormality, interstitial fibrosis, neuro-humoral (RAAS system) alterations are incriminatory.[13,14] Interventions aimed at these pathophysiologic mechanisms can reverse or at least slow down the deterioration in LV function.[15]

In study by Gupta R,[16] majority were from age group of > 54 years (54 %) & male (64 %). ECG revealed that, around 65% of the sample had LVH. 2-D ECHO-LVH/LV Function reveled that, around 36% AND 33% of the sample have Mild concentric LVH and Moderate LV systolic dysfunction and LVH respectively. Majority (71.0%) of the sample have reduced ejection fraction.

Anand V et al.,[17] analysed echocardiographic parameters (E and e') in CKD patients, the stage of renal failure was associated with the significant increase in LVFP with $P < 0.001$. There was a significant correlation between LVFP and eGFR with $r = -0.467$ and $P < 0.001$. The increase in LVFP is directly proportional to the severity of renal failure. Chen SC et al.,[18] noted that patients with CKD stages 3–5 revealed that high E/Ea was associated with increased CV events and progression to dialysis. An E/Ea assessment is also useful for predicting the risk of adverse CV and renal outcomes in CKD patients. [18]

In study by Avijit D et al.,[19] 15% of mild/moderate CKD patients showed low EF & 48% of severe CKD had evidence of low EF. 22% patients with mild/moderate CKD, and 26% with severe CKD had impaired fractional shortening. LVH was 58% among total study population, & it was 33% and 87% among two groups. Among all LVH, 31% was concentric and 69% was eccentric type. Chronic Kidney Disease patients has higher prevalence of left ventricular hypertrophy (LVH) and higher prevalence of systolic dysfunction, which was more pronounced in CKD stage 4-5.

Rao T et al.,[20] studied 250 subjects, 112 (47.8%) had systolic dysfunction and 138 (55.2%) had diastolic dysfunction. The prevalence of systolic as well as diastolic dysfunction increased significantly ($P<0.05$) with deteriorating renal function (39.1% for CKD stage 1 and 67.8% for stage 5 for systolic dysfunction, 34.8% for CKD stage 1 and 77.8% for stage 5 for diastolic dysfunction).

The diagnosis of diastolic dysfunction helps to refine and stratify the cardiovascular risk in CKD population, where it has been little investigated. The pathophysiology of cardiac disease in CKD is related to the interaction of multiple factors including hypertension, chronic

volume overload, anemia, presence of an AV fistula in patients on dialysis, as well as metabolic factors such as acidosis, hypoxia, hypocalcaemia and high levels of parathyroid hormone.

CONCLUSION

The increase in left ventricular filling pressure is directly proportional to the CKD stage i.e., severity of renal failure. Echocardiographic parameter of left ventricular filling pressure can be used as an independent practical predictor of diastolic dysfunction in patients with CKD, useful to predict heart failure.

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