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PREVALENCE OF ECHOCARDIOGRAPHIC ABNORMALITIES AND ITS PATTERNS AMONGST PATIENTS WITH CKD

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Abstract

Background: CKD and cardiovascular diseases co-exist in many patients. The disorders of heart and renal system can deteriorate each other via direct or indirect ways in numerous complex mechanisms. Our study aimed to compare various echocardiographic parameters to predict the progression of CKD. We have conducted the study utilizing both the novel and traditional imaging techniques like speckle tracking for understanding the complex pathophysiological associations between the heart and kidneys.

Methods: This prospective, cross-sectional, observational study was conducted on patients of chronic kidney disease (stage 2-5) to describe echocardiographic abnormalities (anatomical and functional) and its patterns amongst them. A person was considered having CKD if his illness was of more than 3 months' duration and had abnormal USG findings and reduced creatinine clearance pointing to chronic kidney disease. GFR estimation was done using MDRD equation and classified according to the CKD classification. All patients underwent 2D echocardiography and examination was done under various standard echocardiographic views.

Observations: A total of 90 patients in four groups of CKD (stages II, III, IV, V) were evaluated. Out of the 90 patients, 75 patients (83.3%) had LVH. The mean IVSd was 1.37 ± 0.14 cm. The mean LVMI was 134.38 + 24 .91 gm/m2. As the renal functions worsened, there was an increased prevalence of LVH (p=0.0008). There was a significant correlation worsening renal function and the prevalence of left ventricular systolic dysfunction (p<0.0001), left atrium enlargement (p<0.00001), and diastolic dysfunction (p<0.001). We found a strong statistically significant association between GLS and CKD patients with a (p< 0.00001).

Conclusion: There was a significant correlation between LVH, dilated left atrium, abnormal GLS, TR-max velocity, diastolic dysfunction and related TDI parameters with worsening renal functions. Echocardiographic abnormalities are less severe in stage II-III CKD when compared with Stages IV and V CKD.

Key words: CKD, LVH, LVSD, Diastolic dysfunction, GLS.

INTRODUCTION

Chronic kidney disease (CKD) is occurrence of kidney damage or an estimated glomerular filtration rate (eGFR) < 60 ml/min/1.73 mt^2, persisting for 3 months or more, irrespective of the cause. CKD and cardiovascular diseases co-exist in many patients. The prevalence of this co-existing diseases has been progressively increasing. Some important reasons are the association of the CKD with both traditional and non-traditional cardiovascular disease risk factors. CKD is an independent risk factor for occurrence of cardiovascular disease. Also, cardiovascular diseases can itself be a strong predictor of CKD. The disorders of heart and renal system can deteriorate each other via direct or indirect ways in numerous complex mechanisms. Some important cardiovascular symptoms manifested are coronary artery disease, heart failure, various forms of arrhythmias and sudden cardiac death. The traditional risk factors like diabetes, hypertension, smoking plays an important role in cardiovascular complication. According to a report in 2017, the case burden of CKD globally was 9·1%, which roughly was around 700 million cases. The prevalence of CKD has been increasing by 29·3% (26·4 to 32·6) since 1990. Large regional or country-wise differences in the case burden of the CKD with cardiovascular diseases has been observed due to multi-factorial reasons.

Echocardiography is the minimal invasive technique used to evaluate the structural and functional components of the heart used in day-to-day medical practice. It provides thin cross-sections of cardiac structures which helps to identify abnormal left ventricular geometry, reduction in interventricular septum strength & changes in LV mass index and manage various heart diseases. One of the novel techniques developed in recent years is the Two-dimensional (2D) speckle tracking echocardiography (STE). It is a non-invasive assessment of cardiac function. It caters the evaluation of cardiac dysfunction by the utilization of natural acoustic markers (speckles) spread throughout the myocardium. These acoustic markers are further tracked during the cardiac cycle to follow

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myocardial movement. The information obtained from 2D- speckle tracking helps in identifying the myocardial deformation (strain [%]) and velocity of deformation (strain rate [1/s]. With STE exact identification of regional segments with restricted contractility can be done. These non-invasive and non-contrast based diagnostic methods has been used in various conditions of CKD to detect early structural and functional myocardial abnormalities to predict patients at risk for CV disease and help in initiating adequate diagnostic, preventive, and therapeutic measures. Numerous useful information on left ventricular (LV) function like LV ejection fraction (LVEF), stroke volume, cardiac index, fractional shortening, and regional wall motion analysis can be obtained from echocardiography. As a final point, echocardiography tailors as a safe, non-invasive, bedside side test that presents valuable information on the anatomy and function of the heart to the clinician.

In this prospective, cross-sectional, observational, analytical study we performed a complete echocardiographic evaluation of patients with CKD stage II–V sent for evaluation to cardiology department and apart from basic echocardiographic abnormalities like LVH, systolic dysfunction, pericardial effusion, valvular calcification. We have conducted the study utilizing both the novel and traditional imaging techniques like speckle tracking for understanding the complex pathophysiological associations between the heart and kidneys. Our study aimed to compare various echocardiographic parameters to predict the progression of CKD. The objective of this study to describe echocardiographic abnormalities (anatomical and functional) and its patterns amongst patients with chronic kidney disease stages 2 to 5 in a tertiary care hospital.

METHODOLOGY

This prospective, cross-sectional, observational study was conducted in department of cardiology & department of nephrology, S.C.B. Medical College & Hospital, Cuttack during December 2021 to November 2022. After Institutional ethics committee approval, eligible patients were enrolled in the study after obtaining their informed consent form. Diagnosed CKD patients (Stage 2-5) with at least 3 months of duration, irrespective of aetiology sent to cardiology department for evaluation were included in the study. Patients with ischemic /coronary artery disease, congenital heart disease, rheumatic valvular heart disease, restrictive/hypertrophic cardiomyopathy, age less than 18 years, acute Kidney injury, who are not willing to give consent for participation in the study were excluded from the study. After obtaining their informed consent, a detailed history and clinical examination was performed. A total of 90 patients with features of chronic kidney disease were taken. A person was considered having CKD if his illness was of more than 3 months' duration and had abnormal USG findings and reduced creatinine clearance pointing to chronic kidney disease. GFR estimation was done using MDRD equation and classified according to the CKD classification.

All patients underwent 2D echocardiography using Vivid Ge T8 echocardiography machine and GE 3SC-RS Sector Array probe and was done by the Cardiologist who did not know the CKD stage of the patient. Examination was done under various standard echocardiographic views. (Left parasternal long axis, left parasternal short axis, Apical 4 chamber, Apical 5 chamber (for aortic valve flow), Apical 2 chamber & Apical 3 chamber) Measurements was made in the M mode and two-dimensional presentation. Flow parameters were evaluated using Doppler (Continuous wave method- CW, Pulse wave - PW method and Tissue Doppler imaging -TDI). In the study, Volume of left atrium (LA), End-diastolic and systolic dimension of interventricular septum (IVS), posterior wall (PW) and left ventricle (LV) were assessed. Simpson's Biplane method was used to evaluate left ventricular ejection fraction (EF%) indicating LV systolic function.

Diastolic dysfunction was calculated by mitral inflow pattern. The mitral inflow velocities were recorded using pulsed Doppler examination with Doppler sample size placed at tip of mitral leaflets in apical 4 chamber view. Diastolic function was assessed by determining the velocities of early (E) and late (A) diastolic trans mitral flow, normal range of Peak E wave velocity is 66 +/- 15 cm/s in men and in women it is 70 +/-16 cm/s. The normal range for Peak A wave velocity is 67 +/- 16 cm/s in men and 72+/- 18 cm/s in women. The ratio E -to- A(E/A), the range is 1.04+/-0.38 in men and 1.03 +/- 0.34 in women. TDI pulse Doppler at septal and lateral mitral annulus to measure the velocity of myocardial motion. E /average E', E' is the early myocardial velocity, the cut off value taken is septal E' < 7 cm/s or lateral E' <10 cm/s. E/average. E'; average E' is the sum of early myocardial velocities taken at the medial and lateral annulus divided by 2. LA volume index-Left atrium volume measurement was done by biplane area length method, LA volume indexed with BSA, more than 34 ml/m^2 was considered left atrial enlargement. TR max velocity >2.8 m/sec was considered abnormal. Based on the parameters diastolic dysfunction was calculated.

LVH is defined as an increased left ventricular mass index (LVMI) to greater than 95 gm/m^2 in women and increased LVMI to greater than 115 gm/m^2 in men. Concentric LVH is an increased left ventricular mass index with a relative wall thickness > 0.45. Eccentric LVH is an increased left ventricular mass index with a relative wall thickness < 0.45. A septal/LVPW(d) thickness ratio of greater than or equal to 1.3 is common in patients

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with concentric left ventricular hypertrophy and may also occur in normal subjects. LV internal diastolic diameter in M – mode at tip of mitral leaflet above 5.3 cm in females and above 5.9 cm in males was considered as dilated LV. LVid (D) dimensions were indexed with BSA, in males' dimensions above 3 cm/m^2 and in females above 3.5 cm/m^2 was dilated ventricles. Valvular calcification either in aortic or mitral valve or in both valves was considered abnormal. Pericardial effusion present to any degree was considered abnormal.

The endocardial borders were traced in the end systolic frame of the two-dimensional (2D) images from the three apical views. Speckles was tracked frame by frame throughout the LV wall during the cardiac cycle and basal, mid, and apical regions of interest was created. Segments that failed to track were manually adjusted by the operator, GLS was calculated as the mean strain of all 18 segments. Impaired GLS was defined as greater than -17% (a less negative value suggested more impairment).

Statistical analysis

Continuous variables were summarized as mean and standard deviations. P value <0.05 was taken as significant. One-way ANOVA test was used for calculating P value of Age, BMI (body mass index), BSA (body surface area), Haemodynamic parameters, GFR, Haemoglobin, Serum creatinine and Mitral E and A values. Fischer's exact test was used for the distribution of sex ratio, DM (diabetes mellitus), Hypertension, Diastolic dysfunction, pericardial effusion, and calcification among our patients. Chi-square test was used to calculate P value among patients with left ventricular hypertrophy, dilated left ventricle, systolic dysfunction, Left atrial enlargement, TDI velocities, TR max velocities and Global longitudinal strain. The echocardiographic parameters which were found to be significant (P value <0.05) among the participants was compared with stage II CKD patient as a reference value with stage III, IV and V patients separately using chi square test. Statistical analysis was performed using SPSS 21.

RESULTS

In this study, a total of 90 patients in four groups of CKD (stages II, III, IV, V) were taken. These patients were sent to Department of Cardiology for examination and underwent a full echocardiographic evaluation. The data obtained from these patients were analysed with reference to the above-mentioned objectives. Hence, the observations and the results obtained are as follows.

Demographic Features:

Out of the 90 patients considered, patients in stage V of CKD accounted to 32.2% (29 patients) while stage II accounted to 15.5% (14 patients). Percentage of patients in stage III was 26.6% (24 patients) and stage IV was 25.5% (23 patients). In stage II and stage V of CKD, most patients belonged to age 60-69 years. While, age group >70 years was the most common age group in patients of stage III and IV. It was also observed that no patients less than 30 years were encountered throughout the study. In this study it was observed that majority of the CKD patients belonged to male gender (58, 64.4%) when compared to the females (32,35.6%). Details pertaining to age wise distribution, gender wise distribution, body mass index (BMI), body surface area (BSA), comorbidities like diabetes mellitus (DM) & hypertension (HTN) have been mentioned in the table 1 (Demographic details).

Table 1: Demographic Details

1.Stages of CKD	**Stage II**	**Stage III**	**Stage IV**	**Stage V**
n (%)	14 (15.55)	24 (26.66)	23 (25.55)	29 (32.22)
1. Age Distribution (in years)				
18-29	0 (0)	1 (4.16)	1 (4.34)	2 (6.9)
30-39	1 (7.14)	2 (8.33)	5 (21.73)	2 (6.9)
40-49	2 (14.28)	2 (8.33)	1 (4.34)	1 (3.44)
50-59	2 (14.28)	2 (8.33)	4 (17.4)	7 (24.14)
60-69	6 (42.85)	6 (25)	5 (21.74)	13 (44.82)
>70	3 (21.42)	11 (45.83)	7 (30.43)	4 (13.79)
2. **Sex Distribution**				
Male (N=58, 64.4%)	9 (15.5)	17 (29.3)	13 (22.4)	19 (32.8)
Female (N=32, 35.6%)	5 (15.5)	7 (21.9)	10 (31.3)	10 (31.3)
3. BMI (Mean ± SD)	25.32 ± 2.51	24.91 ± 3.16	24.98 ± 3.14	23.17 ± 3.13
4. BSA (Mean ± SD)	1.73 ± 0.12	1.74 ± 0.13	1.74 ± 0.13	1.74 ± 0.12
5. DM, n (%), N=45	9 (64.29)	12 (50)	9 (39.13)	15 (51.72)
6. HTN, n (%), N=73	10 (71.42)	20 (83.34)	18 (78.26)	25 (86.2)

Table 2: Hemodynamic & Biochemical Investigations

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Stages of CKD	**Stage II**	**Stage III**	**Stage IV**	**Stage V**
n (%)	14 (15.55)	24 (26.66)	23 (25.55)	29 (32.22)
Pulse rate (bpm)	85.42 ± 10.15	86.083 ± 10.85	84.086 ± 10.522	86.13 ± 11.98
Systolic blood pressure (mm/Hg)	145.7 ± 12.19	145.8 ± 15.02	154 .1 ± 15.14	151.7 ± 16.9
Diastolic blood pressure (mm/Hg)	87.4 ± 6.26	87.9 ± 6.83	87.7 ± 6.86	89.1 ± 7.86
Mean Haemoglobin (g/dL) Mean ± SD	11.6 ± 1.32	11.4 ± 1.24	10.5 ± 1.29	9.4 ± 1.17
Mean serum Creatinine (mg/dL) Mean ± SD	1.07 ± 0.269	1.46 ± 0.33	2.8 ± 0.32	7.78 ± 1.05
Mean GFR (mL/min/1.73 m^2) Mean ± SD	67.5 ± 4.66	49.16 ± 3.35	23.79 ± 3.21	6.45 0.52

Hemodynamic & Biochemical profile of CKD patients

Haemodynamic parameters like mean pulse rate, systolic blood pressure, diastolic pressure, & mean haemoglobin have been depicted in the table 2. Highest mean systolic BP was observed in stage IV & highest diastolic BP was observed in stage V of CKD. Lowest haemoglobin was seen in stage V of CKD. Mean serum creatinine levels were kept on increasing as the stage of the CKD increases. Mean GFR was keep on decreasing as the stage of the CKD increases.

Echocardiographic atrial & ventricular Findings

While determining the number patients with CKD and LVH, it was seen that 9 (64.2%) patients of Stage II, 18 (75%) of Stage III, 21 (91.3%) of stage IV and 27 (93.1%) of stage V had concurrent LVH. More number of CKD stage V patients had LVH. The mean Interventricular septal thickness in end diastole (IVSd- 1.47 ± 0.18) & LVPW (1.14 ± 0.12) in the patients with LVH was found to be higher in stage V CKD patients.

Table 3: Echocardiographic atrial & ventricular Findings				
Stages of CKD	**Stage II**	**Stage III**	**Stage IV**	**Stage V**
n (%)	14 (15.55)	24 (26.66)	23 (25.55)	29 (32.22)
LVH, n (%)	9 (64.2)	18 (75)	21 (91.3)	27 (93.1)
IVSd, Mean ± SD	1.29 ± 0.13	1.35 ± 0.12	1.37 ± 0.16	1.47 ± 0.18
LVPW, Mean ± SD	1.02 ± 0.09	1.08 ± 0.09	1.19 ± 0.12	1.14 ± 0.12
RWT, Mean ± SD	0.43 ± 0.05	0.45 ± 0.04	0.49 ± 0.06	0.45 ± 0.04
LVMI, Mean ± SD	116.97 ± 17.33	126.86 ± 18.09	142.29 ± 33.60	151.42 ± 30.64
LVIDd, Mean ± SD	4.67 ± 0.31	4.73 ± 0.25	4.82 ± 0.35	5.06 ± 0.36
Systolic Dysfunction, n (%)	0 (0)	6 (25)	8 (34.7)	8 (27.5)
LVEF, Mean ± SD	59.06 ± 2.9	52.5 ± 6.3	48.58 ± 6.92	46.905 ± 7.46
LA enlargement, n (%)	1 (7.1)	6 (25)	15 (65.2)	24 (82.7)
LA Volume, Mean ± SD	26.81 ± 4.76	27.64 ± 4.08	35.29 ± 5.13	40.2 ± 3.86

Distribution of Relative wall thickness (RWT)

RWT was calculated by the formula, (2 X LVPW)/ LViDd:
The results are tabulated below,
P value= 0.018.

Distribution of LVMI:

LVMI was calculated using modified Devereux equation:
LVM (left ventricular mass) = 0.8 {1.04[([LVEDD + IVSD + PWd]^3-LVEDD^3)]} + 0.6
The distribution of LVMI has been tabulated below.
P value= 0.0008.

In our study, 30 female patients had LVMI >95g/m^2 and 45 male patients had LVMI >115 g/m^2, 27 female patients and 41 male patients had RWT > 0.42 suggesting concentric LVH.

Distribution of dilated left ventricle:

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We found that none of the patients in stage II CKD suffered from dilated left ventricle. Stage V CKD had 6 patients with dilated ventricles. Stage III had 5 patients and stage IV had 5 patients with dilated ventricles. On determining the left ventricular internal dimensions at end-diastole (LVIDd), the mean LVIDd are as follows:
p value of 0.269776657.

Distribution of systolic dysfunction:
We aimed to assess the number of patients with systolic dysfunction in various stages of CKD. The table given below depicts the number of patients with systolic dysfunction.
The mean Left ventricle ejection fraction (LVEF) was estimated in all the patients included in the study.
The p-value is p<0.0001. The result is significant at p < .05. The maximum mean LVEF was witnessed in stage II of CKD 59.06 ± 2.9, and the minimum was in stage V of CKD- 46.905 ± 7.46.

Distribution of Left atrium (LA) enlargement:
In this study LA enlargement (LA volume index more than 34 mL/m^2) was highest noted in stage V with 24 patients (82.7%) and the least in stage II with 1 patient (7.1%).
Mean LA volume index was estimated in various stages of CKD. They are as follows:
The p-value is < .00001. The result is significant at p < .05.

Table 4: Echocardiographic valvular Findings

Stages of CKD	**Stage II**	**Stage III**	**Stage IV**	**Stage V**
n (%)	14 (15.55)	24 (26.66)	23 (25.55)	29 (32.22)
Mitral E velocity	92.005 ± 26.95	74.52 ± 12.40	80.63 ± 12.93	88.07 ± 24.94
Mitral A velocity (mean ± SD)	84.81 ± 6.93	87.70 ± 22.1	81.44 ± 13.1	84.8 ± 7.52
Mitral E/A	1.09 ± 0.3	0.89 ± 0.26	0.99 ± 0.04	1.04 ± 0.32
Septal TDI velocity E' (cm/sec), Mean ± SD	7.92 ± 2.95	6.49 ± 2.08	5.3 ± 1.6	5.41 ± 3.86
TDI velocity (cm/sec), Mean ± SD	11.78± 2.5	9.49 ± 2.08	7.89 ± 1.6	7.41 ± 1.8
Avg E' (mean ± SD)	9.17 ± 0.56	7.58 ± 0.68	6.54 ± 0.53	6.22 ± 0.59
E/ avg E' (mean ± SD)	10.08 ± 3.05	9.93 ± 1.95	12.41 ± 2.26	14.26 ± 4.05
Number of patients with E/ avg E' >14	2	1	5	14
TR max, Mean ± SD	2.19 ± 0.04	2.49 ± 0.2	2.81 ± 0.07	2.83 ± 0.07
GLS, Mean ± SD	-16.3 ± 0.83	-15.13 ± 0.55	-12.13 ± 0.66	-12.17 ± 0.6
Diastolic dysfunction				
Normal	12 (85.7)	13 (54.1)	3 (13.04)	4 (13.7)
Indeterminate	2 (14.2)	4 (16.6)	5 (21.7)	3 (10.3)
Present	0 (0)	4 (17.3)	10 (47.8)	21 (72.4)

Distribution of mitral inflow patterns:
In our study, maximum E velocity was seen in stage II CKD and maximum A velocity was seen in stage III CKD patients.
The p-value is 0.052 for mitral E velocity and the p-value is 0.41 for mitral A velocity.

Distribution of tissue doppler velocity E' (TDI)

- **Septal TDI E':**

In our study, minimal mean septal TDI velocity E' (5.30 ± 1.6 cm/sec) was observed in stage IV CKD patients. While, maximum (7.92 ± 2.95 cm/sec) was noticed in stage II CKD patients.
P value was <0.001. The result is significant at p < 0. 05 .

Stage V patients – 25 patients (86.2%) were having maximum number of patients and 4 patients(28.5%) with reduced septal TDI E'and stage II CKD had the minimum.

- **Lateral TDI E'**

In our study, minimal mean lateral TDI velocity E'was observed in stage V (7.41 ± 3.86 cm/sec) patients, while, the maximum was in stage II CKD patients (11.78± 3.95 cm/sec). Stage V had maximum number of patients with 25 patients (86.2%) and stage II had the minimum number of patients 4 patients (28.5%) with reduced lateral TDI.
P value was <0.001. The result is significant at p < 0. 05

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- **Average TDI E' and E/ avg E'**

We found that maximum mean E/ avg E' ratio was seen in stage V. However, the minimum mean E/avg E' was seen in stage II CKD. Also, maximum patients with E/ avg E' ratio >14 were in stage V and only 1 patient had the ratio > 14 in stage II CKD.
P value is <0.00001.
P value is <0.0001.

Table 5.25:Distribution of patients with E/avg E' >14 in various stages of CKD

Stage of CKD	Number of patients with E/ avg E' >14
Stage II	2
Stage III	1
Stage IV	5
Stage V	14

Distribution of tricuspid regurgitation velocity

Study showed the maximum mean TRmax velocity of 2.83 ± 0.07 m/sec in stage ± 0.07 CKD and minimum was in stage II CKD with 2.19 ± 0.04 m/sec. Stage II had 1 patient (7.14%) patient with TRmax >2.8 m/sec, stage III with 7 (29.19%), stage IV 12 (52.1%) and stage V 19 (65.5%) patients.

TR max	Stage II	Stage III	Stage IV	Stage V
Mean ± SD	2.19 ± 0.04	2.49 ± 0.2	2.81 ± 0.07	2.83 ± 0.07

Table 5: Mean TRmax velocity in various stages of CKD

The p-value is < .00001. The result is significant at p < 0.05.

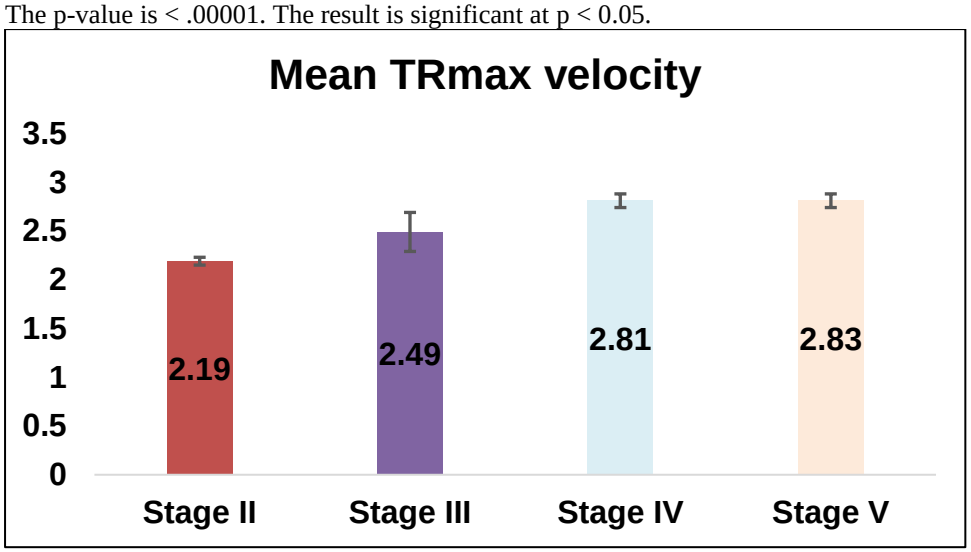

Figure 1: Mean TRmax velocity in patients of various stages of CKD

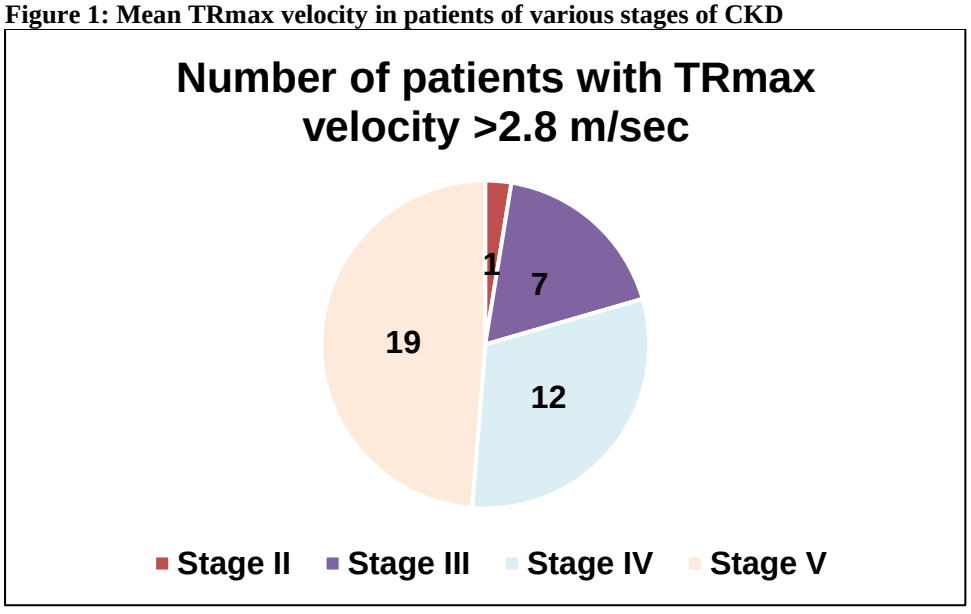

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Figure 2: Distribution of patients with TRmax velocity >2.8 m/sec in various stages of CKD

Distribution of Global Left ventricular strain (GLS)

In our study, maximum mean GLS was seen in stage V CKD patients which was -12.17% and minimum mean GLS was seen in stage II CKD patients which was -16.3% . Stage II CKD patients did not have any patients with GLS > -17%. While stage III patients had 16 (66.6%), stage IV had 18 (78.2%) and stage V had 24 (82.7%) patients with GLS >-17%.

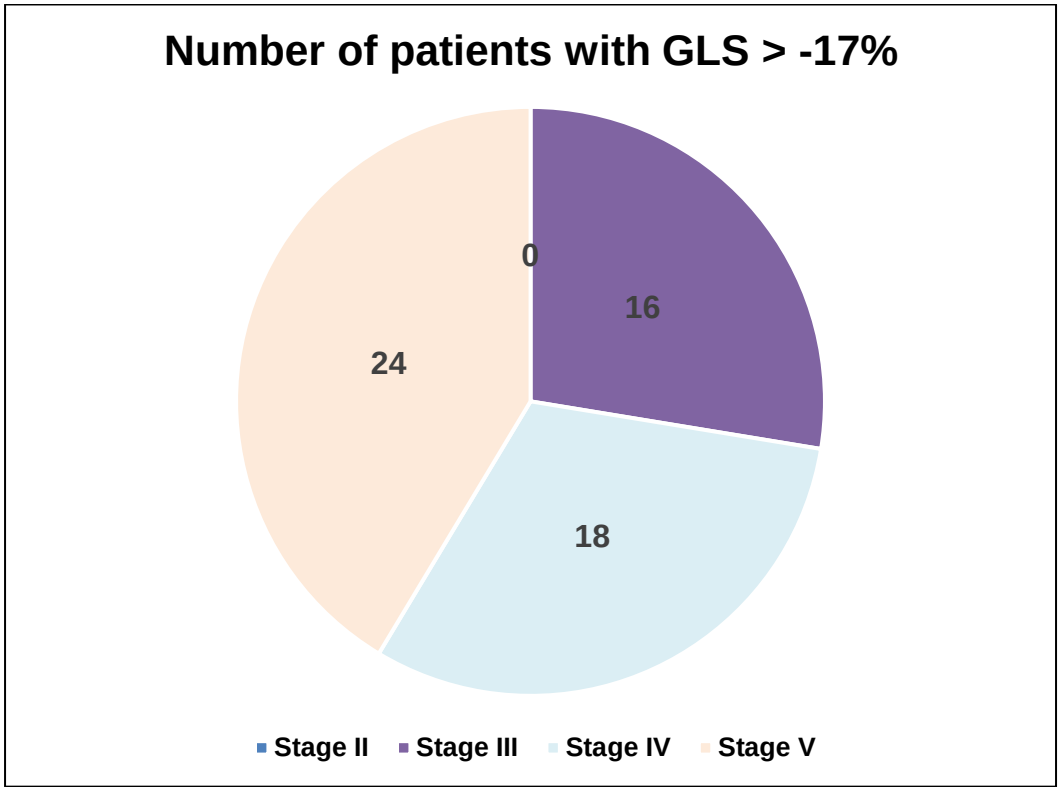

Figure 3: Distribution of patients with GLS >-17% of various stages of CKD

Table 6: Mean GLS in patients of various stages of CKD

GLS	Stage II	Stage III	Stage IV	Stage V
Mean	-16.3	-15.13	-12.13	-12.17
SD	0.83	0.55	0.66	0.6

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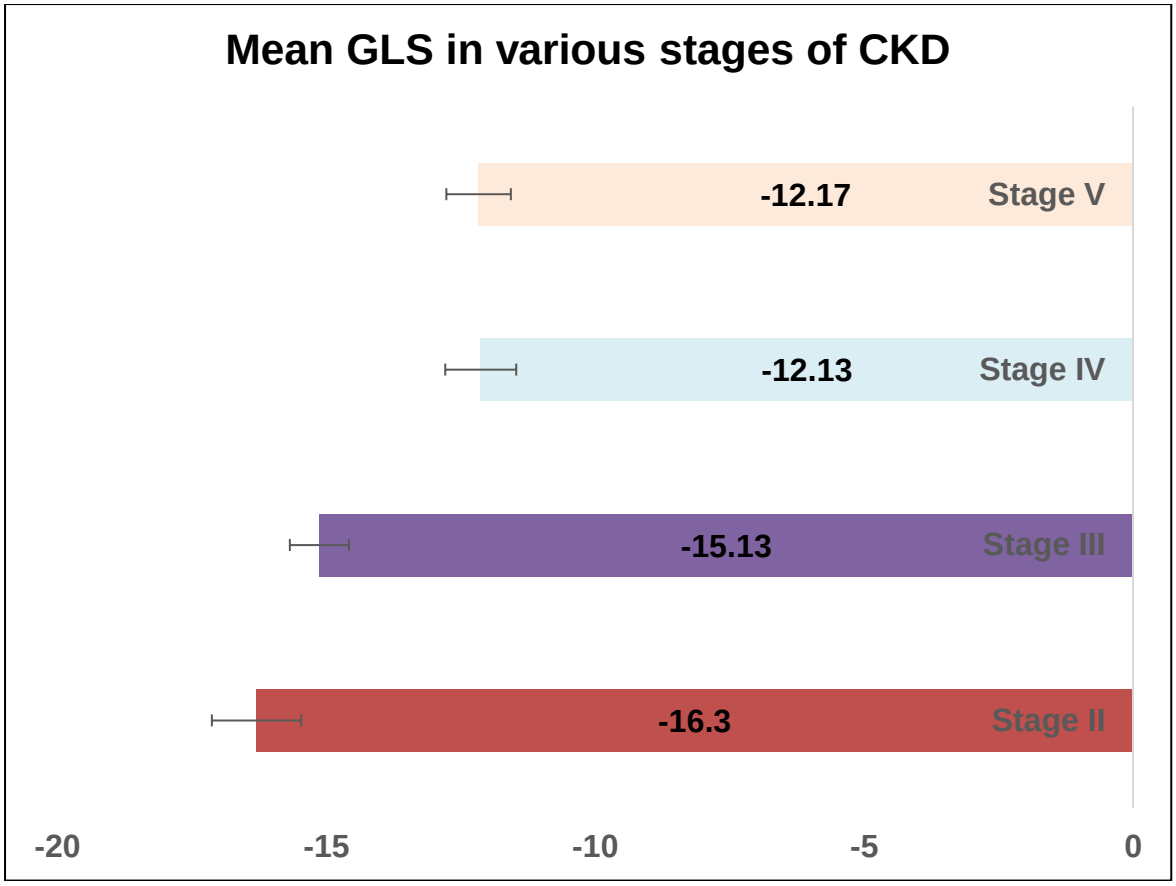

Figure 4: Mean with GLS >-17% of various stages of CKD
The p-value is < .00001. The result is significant at p < .05.

Distribution of valvular calcification:
In our study, we aimed to assess the number of patients in various stages of CKD with valvular calcification. The maximum number of valvular calcifications were seen in stage V- 10 patients (34.5%) and a single patient had valvular calcification in stage II CKD.

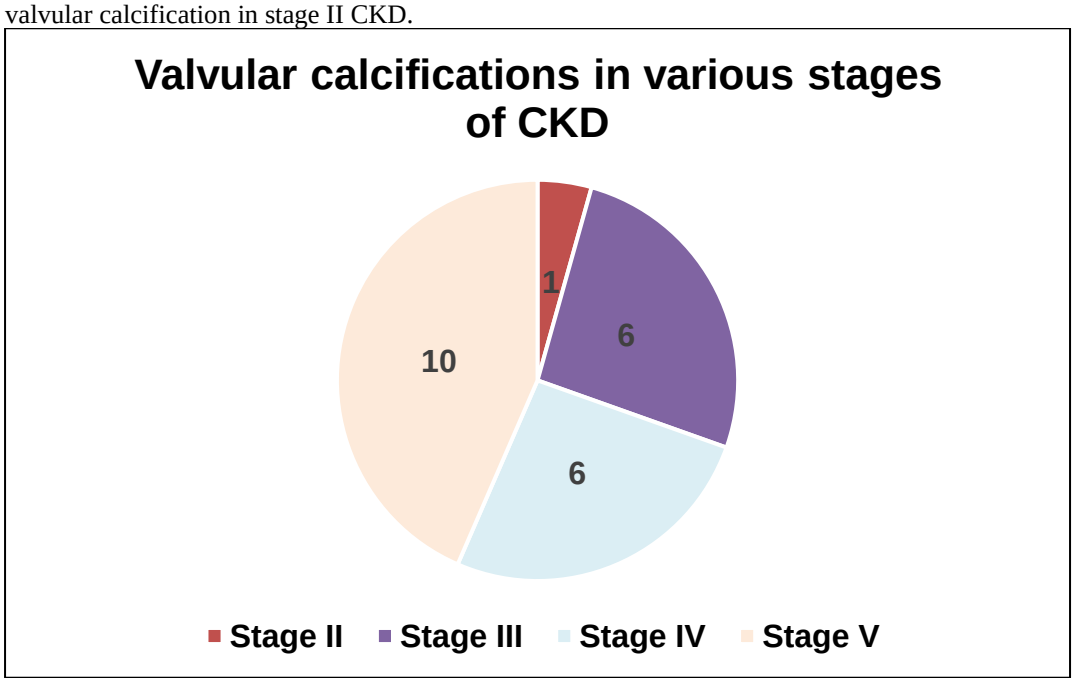

Figure 5: Distribution of valvular calcifications in patients of various stages of CKD

Distribution of pericardial effusion:

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Pericardial effusion was not seen in patients of stage II and III CKD. While, 1 patient (4.3%) in stage IV and 4 patients (13.8%) in stage V showed signs of pericardial effusion on echocardiography.

Distribution of diastolic dysfunction:

In our study, stage II CKD had no patients with diastolic dysfunction. Out of 29 patients in stage V: 21 (72.4%) patients had diastolic dysfunction. Stage III had 4 (17.3%) patients and stage IV : 10 (47.8%) had diastolic dysfunction. p <0.001 was observed.

Table 7: Patients with diastolic dysfunction in various stages of CKD

Diastolic dysfunction	Stage II n (%)	Stage III n (%)	Stage IV n (%)	Stage V n (%)	Total n (%)
Normal	12 (85.7)	13 (54.1)	3 (13.04)	4 (13.7)	32 (35.5)
Indeterminate	2 (14.2)	4 (16.6)	5 (21.7)	3 (10.3)	14 (15.5)
Present	0 (0)	4 (17.3)	10 (47.8)	21 (72.4)	35 (38.8)

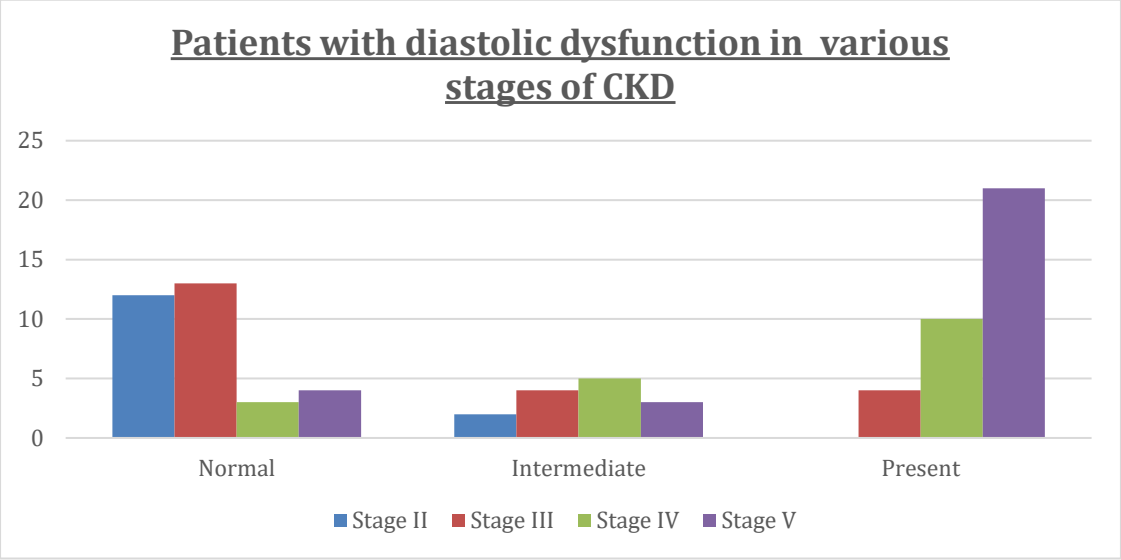

Figure 6: Patients with diastolic dysfunction in various stages of CKD

DISCUSSION

Cardiovascular disease is a significant cause of morbidity and mortality among patients with chronic kidney disease (CKD). Cardiac structural as well as functional abnormalities are common in patients with end stage renal disease and chronic kidney disease. Echocardiography is easily performed, non-invasive, cost-effective, safe, reproducible and accurate in early assessment of cardiac function in CKD which is important for risk stratification and early preventive measure. We conducted this observational study to investigate the prevalence of echocardiographic abnormalities and its patterns amongst 90 patients with CKD stages II to V in Department of Cardiology & Department of Nephrology, S.C.B. Medical College and Hospital, Cuttack. We found that maximum number of patients i.e. 29 patients were in CKD stage V and the least number of patients i.e., 14 patients in stage II. Stage III and stage IV had 24 and 23 patients respectively.

Left ventricular hypertrophy is one of the most commonly occurring abnormalities in CKD patients on echocardiography are associated with greater rate of declining renal function, greater morbidity and mortality. Out of the 90 patients, 75 patients (83.3%) had LVH. The mean IVSd was 1.37 ± 0.14 cm; 27 females and 41 males had LVMI more than 95 and 115 gm/m^2 respectively with RWT more than 0.42 suggesting concentric hypertrophy. We could conclude that the prevalence of LVH increases as renal function worsens. As we progress from stage II to stage V, mean septal thickness increases from 1.29 ± 0.13 to 1.47 ± 0.18. when compared to patients of various stages of CKD, we found significant difference in the LVH with the p-value is 0.0008. The number of patients with LVH were 9 (64.2%), 18 (75%), 21 (91.3%) and 27 (93.1%) in stage II, stage III, stage IV, stage V of CKD respectively. As the renal function deteriorates, the prevalence of LVH increases. Study conducted by Meyeon P

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et al, measured LV mass for LVH and they found a linear correlation and significant association between LV mass and worsening kidney functions. These results correlates with our study [3]. Study by Garg P et al, LVH was present in 46.67% patients in CKD stage II, 69.23% in stage III, 76.19% in stage IV, and 92.86% in stage V. Mean IVS thickness was 1.19, 1.30, 1.30, and 1.42 cm in stage II, III, IV, and V CKD patients, respectively [4]. In our study, left ventricular systolic function was measured by Simpson's biplane method. Left ventricular dysfunction was labelled when LVEF was less than 50%. Out of the 90 patients included, 22 (24.44%) patients had systolic dysfunction. Maximum mean LVEF was observed in stage II with 59.06 ± 2.9 and the least in stage IV with 46.90 ± 7.46. There was significant correlation seen with worsening renal function and the prevalence of left ventricular systolic dysfunction ($p < 0.0001$). Study conducted by Barde R et al on 100 patients on maintenance dialysis found systolic dysfunction in 28 (28%) patients, but they used criteria of LVEF <55% as systolic dysfunction [5]. We found a similar prevalence of systolic dysfunction in CKD stage V; we had 8 patients in stage V CKD with systolic dysfunction. Meyeon P et al found systolic dysfunction (defined as ejection fraction <45%) in only 8% of cohort. Majority 82% had EF >50%, only 10% patients had EF= 46 – 50%, 6% of patients had 36-45% and 2% had ≤ 35%. They found there was no association between kidney function and systolic dysfunction in demographic, multivariate or fully adjusted models [3].

Measurement of Tricuspid regurgitation maximum velocity (TRmax) on continuous wave doppler was done. TRmax velocity >2.8 m/s was considered abnormal. Mean velocity in our study was 2.57 ± 0.29 m/s. 39 (43.33%) patients had the mean velocity >2.8 m/s. We found a statistically significant association between CKD stages and TRmax as p was < .00001. It meant that deteriorating renal function is associated with increasing TRmax velocity. Hence, associated with pulmonary artery hypertension. We further compared stage II with rest of the stages, found significant association. In this study, we calculated Global Longitudinal Strain (GLS). It is the novel approach to detect subclinical abnormalities in myocardium in CKD patients at an early stage when all the other parameters are still normal. GLS>(-17%) (a lesser negative value) was considered abnormal. In our study, we found a strong statistically significant association between GLS and CKD patients with a p-value < .00001. Mean GLS of -13.95 ± 2.11. Out of the 90 patients, 58 patients (64.44%) were having their GLS>(-17%). As we progressed from stage II to stage V, GLS progressively increased (became less negative). None of the patients with GLS >(-17%) in stage II, while 16 (66.67%) in stage III, 18 (78.2%) in stage IV and 24 (82.7%) in stage V. We compared the prevalence of GLS between CKD stage II and the rest of CKD patients and found there was no significant difference. GLS was the only parameter among the other abnormalities which showed a significant difference between stage II and Stage III. Hence, this parameter can be used as a novel modality for subclinical cardiac dysfunction as patient progresses from stage II to stage III CKD. Concluding that, GLS detects subclinical changes in myocardium even when patient progresses from stage II to stage III. In a study carried out by Liselotte CR et al on 304 patients from stage IIIb to Stage V found a mean GLS of -14 ± 5% and they found a significant association between the two [6]. In a study by Garg P et al, they found statistically significant association between GLS and CKD patients as our $P < 0.001$. As we progress from stage II to stage V, GLS progressively increased (became less negative). There was significant difference between stage II versus III, II versus IV and II versus V, as $P < 0.001$ in all three comparison groups [4]. Study by Krishnasamy et al. on CKD patients found mean GLS of −16.6% ± 4.2%. eGFR correlated negatively with GLS ($r = −0.14$, $P = 0.004$) similar to our study [7].

A thorough examination of the diastolic function was done. We used new recommendation by ASE to grade diastolic dysfunction, which rely on TDI, LA volume, TRmax, E/E'. By using these new parameters, we were able to classify the dysfunction more accurately. As some other studies did not consider TDI velocities, pseudo normal mitral inflow patterns were reported as normal and some others classified grade I diastolic dysfunction as actual dysfunction, in real it was having a normal left atrial pressure.In patients with normal LVEF, they were classified in three stages as normal, intermediate and definite diastolic dysfunction. In patients with reduced LVEF, patients were classified as normal, grade I, grade II or grade III diastolic dysfunction. In our study, only patients with definite diastolic dysfunction, grade II or III was classified as having an actual dysfunction, rest were considered normal. Out of the 90 patients, stage II CKD had no patients with diastolic dysfunction. Out of 29 patients in stage V: 21 (72.4%) patients had diastolic dysfunction. Stage III had 4 (17.3%) patients and stage IV : 10 (47.8%) had diastolic dysfunction. 35 (38.89%) had an actual diastolic dysfunction according to the new recommendations. A strong correlation between CKD patients and diastolic dysfunction with a $p < 0.001$ was observed. We found no statistical significance in stage II vs rest of the stages of CKD. Meyeon P et al study, diastolic dysfunction was normal in 29% of the total cohort (with a distribution of 38%, 25%, 26% AND 23% of participants with eGFR ≥ 60, 45-59, 30-44, <30 ml/min/1.732 m^2 [3].

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