

Electrocardiographic and Echocardiographic changes in Non-Hemodialysis Chronic Kidney Disease Patients: A Cross-Sectional Study

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Date of Submission: 03/12/2023

Date of Review: 22/03/2024

Date of Acceptance: 17/04/2024

ABSTRACT

Chronic Kidney Disease (CKD) patients have a higher risk of cardiovascular manifestations such as coronary artery disease, heart failure, arrhythmias, and sudden cardiac death. Cardiovascular diseases are the main cause of death in patients with advanced CKD, rather than end-stage kidney disease itself. Essentially, CKD speeds up the ageing process in the cardiovascular system. **Objectives:** To determine the prevalence of cardiovascular abnormalities in non-hemodialysis CKD patients. **Methods:** A descriptive cross-sectional study, was conducted in the Department of Medicine, between October 2020 to September 2022. A total of 50 CKD patients were included. The patients were evaluated & enrolled in the study, based on history, general physical examination, systemic examination, Blood Urea, Serum Creatinine, Urine Routine, Electrocardiograph (ECG) and Echocardiography. **Results:** In the present study Electrocardiograph & echocardiography determined cardiovascular abnormalities in 68% of patients. Among these 50% of patients had Left Ventricular Hypertrophy (LVH) & Left Ventricular Diastolic Dysfunction (LVDD), 8% of patients had Arrhythmias and 6% patients had conduction abnormality, 2% patients had LVH and 2% patients had LVDD. **Conclusion:** LVH & LVDD are the most common morphological abnormalities observed in our study. We can diagnose Arrhythmias and conduction abnormality by electrocardiogram & echocardiography and refer them for appropriate interventions promptly.

KEYWORDS: Electrocardiograph, Chronic Kidney Disease, Echocardiography

INTRODUCTION

Chronic kidney disease (CKD) is a global public health concern characterized by a progressive decline in glomerular filtration rate (GFR) and loss of functional nephrons. [1] This decline in kidney function leads to a multitude of complications, with cardiovascular issues being a major contributor to morbidity and mortality. [1, 2] While existing research has extensively documented the cardiac manifestations in hemodialysis patients with CKD, a distinct understanding of these changes in non-hemodialysis CKD patients is crucial.

CKD prevalence varies geographically, with India facing a significant burden, particularly from chronic interstitial nephropathy of unknown etiology (CKDu). [2, 3] The reported prevalence varies across different regions, ranging from less than 1% to 13%. However, recent data from the International Society of Nephrology's Kidney Disease Data Center Study suggests a prevalence of 17%. [3] The etiology of CKD varies considerably throughout India. Parts of the states of Andhra Pradesh, Odisha, and Goa have high levels of CKD of unknown etiology (CKDu), which is chronic interstitial nephropathy with insidious onset and slow progression. Data from the National Health and Nutrition Examination Survey showed that CKD prevalence among ages 60 and above increased from 18.8% in 1988-1994 to 24.5% in 2003-2006. [4, 5]

Early identification and management of cardiac complications in this population are essential for improved patient outcomes.

Echocardiography is a valuable tool for assessing cardiac structure and function. Studies have demonstrated

a high prevalence of echocardiographic abnormalities in patients with end-stage renal disease (ESRD) undergoing hemodialysis.^[6] However, a clear understanding of the spectrum of these abnormalities in non-hemodialysis CKD patients remains limited.^[6, 7]

This study aims to investigate the specific electrocardiographic (ECG) and echocardiographic changes in non-hemodialysis CKD patients. By isolating the cardiac manifestations unique to this population, we hope to pave the way for tailored monitoring and intervention strategies, ultimately improving their cardiovascular health and overall prognosis.

MATERIAL & METHODS:

Study Design: A descriptive cross-sectional study was conducted at the Department of Medicine, Institute of Medical Science & Research, Jalna, India, from October 2020 to September 2022.

Participants: Patients diagnosed with chronic kidney disease (CKD) and not undergoing dialysis were recruited as per the following criteria:

Inclusion Criteria:

- Diagnosed with chronic kidney disease (CKD)
- Not undergoing dialysis
- Evidence of kidney injury lasting >3 months with at least one of the following:
 - Structural or functional kidney damage (with or without decreased GFR)
 - Evidence of kidney damage on imaging tests
 - Markers of kidney damage in blood or urine composition
- GFR < 60 ml/min/1.73 m²

Exclusion Criteria:

- Documented ischemic heart disease
- Congenital heart diseases
- Valvular heart disease
- Primary cardiomyopathies

Informed consent was obtained after explaining the study objectives and methods. Following informed consent, researchers collected data through two primary methods:

1. **Patient Interviews:** A structured questionnaire captured demographic information, detailed medical history, and physical examination findings with a particular focus on cardiovascular signs and symptoms.
2. **Medical Record Review:** Researchers reviewed participants' medical records to gather information on relevant past medical history, laboratory test results, and any prior imaging studies.

Patients were followed up until they were discharged. All enrolled patients underwent following investigations:

Electrocardiography (ECG):

All participants underwent a standard 12-lead ECG upon admission. A qualified cardiologist reviewed and analyzed the ECGs for the following parameters:

- **Rhythm and Rate:** Heart rhythm (e.g., sinus rhythm, atrial fibrillation) and heart rate (beats per minute).
- **Axis:** Frontal QRS axis (electrical conduction direction through the ventricles).
- **Waveform Analysis:** Morphology and duration of P wave, PR interval, QRS duration, presence of pathological Q waves, fragmented QRS complex, ST-segment deviation (elevation or depression), QT interval, and T wave abnormalities.
- Standardized criteria established in references^[8, 9] were used to define ECG abnormalities.

Echocardiography:

Two-dimensional (2D) echocardiography was performed using a Wipro GE VividS5 machine with a 3 MHz probe. Patients were positioned in the left lateral decubitus position to optimize image acquisition. The following echocardiographic views were obtained:

- **Left Parasternal:** Long axis and short axis views for assessment of ventricular size, wall thickness, and valvular function.
- **Apical:** Four-chamber, five-chamber (aortic valve flow visualization), two-chamber, and three-chamber views for evaluation of chamber sizes, valvular function, and overall cardiac function.
- **M-mode:** This mode provides a single-dimensional view of the left ventricle, allowing measurement of wall thickness and contractility.

Statistical Analysis:

The Statistical Package for Social Sciences (SPSS) version 21 was used to analyze the collected data. Data were expressed as mean values ± standard deviations (SD) for continuous variables. Frequency and proportions were reported for categorical variables. The p-value of < 0.05 was considered statistically significant.

RESULT:

The majority of cases were in the age group of 41-50 (44%). In the study 62% of patients were females and 38% of patients were males Table 1.

Total of 80% of cases were hypertensive and 38% were diabetic patients.

Characteristics	No. of patients
Age	
41 to 50	44
51 to 60	27
Above 60	29
Sex	
Male	38
Female	62
Co-morbidities	
DM	8
HTN	50
DM and HTN	30
No DM and/or HTN	12

Table 1: Baseline Characteristics of CKD patients in the study

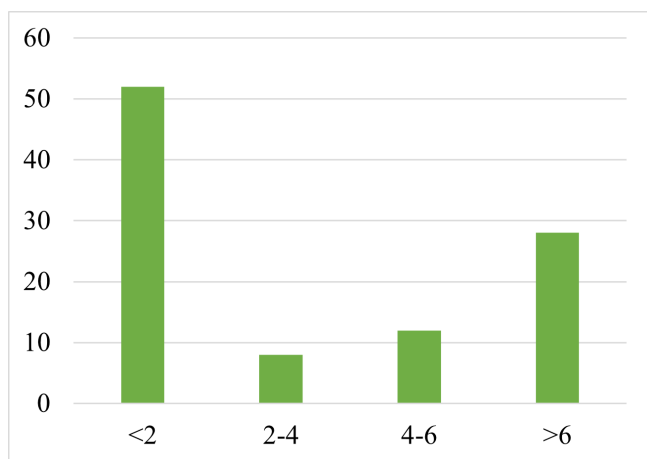


Figure 1: Duration of CKD (in yrs) & number of patients (in %)

The majority of patients (52%) were diagnosed with CKD recently in our study Figure 1.

Left ventricular hypertrophy (LVH) and left ventricular diastolic dysfunction (LVDD) were the most frequently detected abnormalities, identified in 50% of patients Figures 2 and 3. Additionally, 8% and 6% of patients exhibited arrhythmias and conduction abnormalities, respectively. Figure 4

Figure 4 shows, there are (92%) of patients with no arrhythmias, while 8 % had arrhythmias. Of them, 6% had atrial fibrillation and 2% had Ventricular Premature Complexes.

The majority of patients (58%) had Blood Urea levels less than 100 mg/dl and 20 % of cases had Urea levels more than

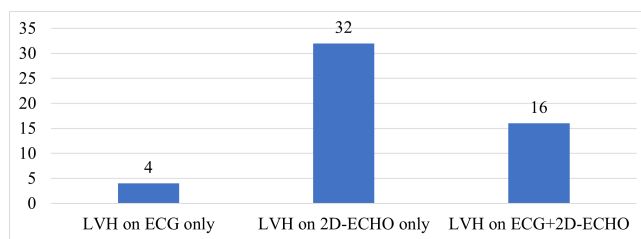


Figure 2: Left Ventricular Hypertrophy on ECG and 2D-ECHO (%)

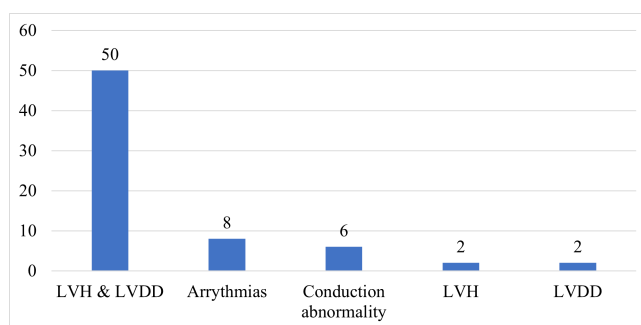


Figure 3: Cardiovascular abnormalities in non-hemodialysis CKD patients (%)

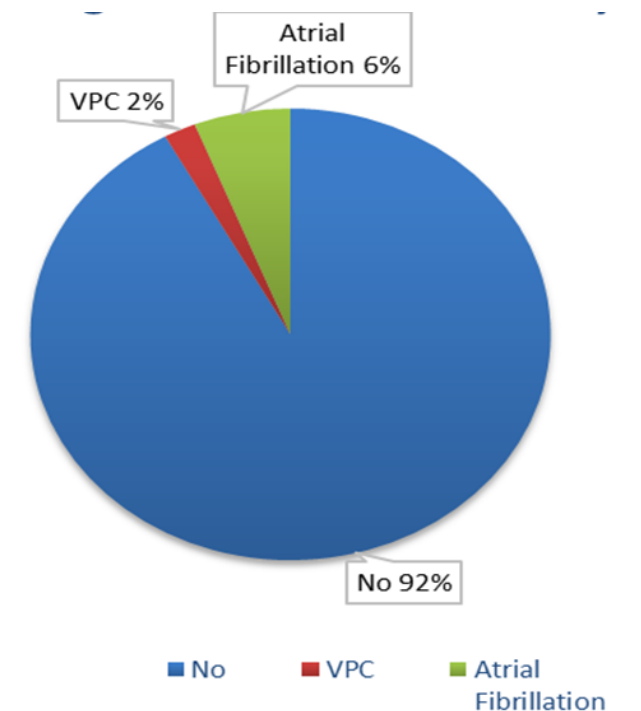


Figure 4: Presence of arrhythmias in CKD patients

150 mg/dl. The majority of cases (58%) had Serum creatinine levels in between 2 to 4 mg/dl and 22% of cases had Serum creatinine levels more than 6 mg/dl. Maximum number of patients (56%) had serum potassium levels in the range of 4 to 4.5 mEq/L. 4 cases (8%) had serum potassium levels more than 5 mEq/L. Chest X-rays of 6 % of cases showed Cardiomegaly.

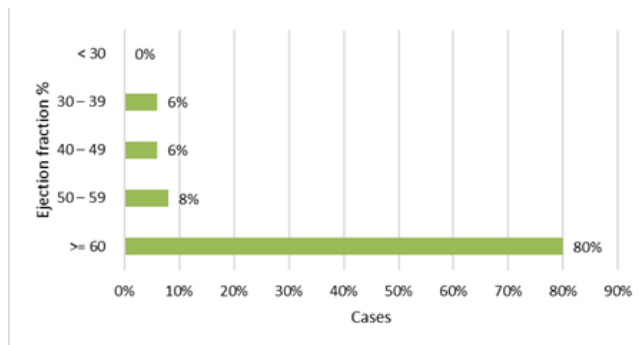


Figure 5: Ejection Fraction percentage in CKD patients

DISCUSSION:

Chronic kidney disease (CKD) is a well-established risk factor for cardiovascular complications [1, 2]. Early detection and management of cardiac abnormalities can significantly improve patient outcomes. [10] This study aimed to investigate the prevalence of electrocardiographic (ECG) and echocardiographic abnormalities in a cohort of non-dialysis-dependent CKD patients.

Patient Characteristics and Comorbidities:

The study included 100 patients with CKD, with an age range of 40-70 years. The majority (44%) belonged to the 41-50 year age group, similar to findings reported by Goornavar et al. [11] Interestingly, females comprised a larger proportion (62%) compared to males (38%). This gender distribution contrasts with some previous studies where diabetes mellitus (DM) was identified as the leading cause of CKD, with a higher prevalence in males. [12, 13] In our study, hypertension (50%) emerged as the most prevalent comorbidity, followed by DM (30%). This suggests potential regional variations in the etiology of CKD.

K.D. Singh et al. [14] study on ECG and echocardiographic changes in patients with chronic kidney disease (CKD) observed comorbidities were diabetes mellitus in 18 patients, chronic glomerulonephritis in 6 patients, hypertension in 8 patients, DM+HTN in 36 patient, and other in 32 patients.

N.P Singh et al. [13] found the most common cause to be Chronic Glomerulonephritis (67%) followed by DM (25%) whereas D. S. Chafekar et al. [15] concluded that the most common cause for CKD to be Chronic Glomerulonephritis (38.75%) followed by DM (6.25%).

The data in other studies varies significantly from the present study because of the random selection of the cases and regional variation in the incidence of diseases which are known to cause chronic kidney disease.

Hyperkalemia is a frequently encountered electrolyte abnormality in CKD. Our study observed a K⁺ level >4.5 mEq/L in 16% of patients, with a mean K⁺ of 4.73±1.13 mEq/dl, which aligns with the findings of N.P. Singh et al. [13]

ECG and Echocardiographic Findings:

The prevalence of ECG and echocardiographic abnormalities in our study population was significant. Left ventricular hypertrophy (LVH) and left ventricular diastolic dysfunction (LVDD) were the most frequently detected abnormalities, identified in 50% of patients. Additionally, 8% and 6% of patients exhibited arrhythmias and conduction abnormalities, respectively. These findings are comparable to the observations of K.D. Singh et al. who reported ECG abnormalities in 72% of CKD patients, including LVH (30%) and arrhythmias (6%). [14]

Correlation between CKD Severity and Cardiac Abnormalities:

Our study suggests a positive correlation between the severity of CKD and the prevalence of cardiac abnormalities. This aligns with previous research highlighting a higher burden of cardiac complications in patients with advanced CKD stages. [11, 14]

Our study aligns with recent findings by Ishigami et al. [16] in a larger CKD population. They reported that abnormal cardiac structure and function, assessed by echocardiography, predicted a higher risk of kidney failure and a faster decline in kidney function. This emphasizes the importance of regular echocardiographic evaluation for CKD patients to identify and manage cardiac dysfunction early, potentially improving overall prognosis. [17]

CONCLUSIONS

This study underscores the importance of routine ECG and echocardiographic evaluation for early detection of cardiac dysfunction in non-dialysis dependent CKD patients. LVH and LVDD emerged as the most prevalent abnormalities in our cohort. Echocardiography proved to be a valuable tool for identifying early cardiac changes, potentially leading to prompt intervention and improved patient outcomes. The observed correlation between CKD severity and cardiac abnormalities suggests the need for periodic echocardiographic monitoring (every 3-6 months) tailored to individual patient needs.

LIMITATIONS:

This study was limited by its relatively small sample size and its single-center design. Future multicenter studies with larger patient populations are warranted to confirm these

findings and explore potential regional variations in CKD etiology and associated cardiac complications.

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How to cite this article: Ansari MSHK, Noorani MSS, Shaikh AFAH. Electrocardiographic and Echocardiographic changes in Non-Hemodialysis Chronic Kidney Disease Patients: A Cross-Sectional Study. *Perspectives in Medical Research*. 2024;12(1):19-23
DOI: [10.47799/pimr.1201.04](https://doi.org/10.47799/pimr.1201.04)