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STUDY OF CARDIAC CHANGES IN CHRONIC KIDNEY DISEASE USING ECG AND ECHOCARDIOGRAPHY

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ABSTRACT:

Chronic Kidney Disease (CKD) is a major global health burden and is associated with a significantly increased risk of cardiovascular morbidity and mortality. Cardiac complications are the leading cause of death among CKD patients due to structural and functional alterations in the myocardium resulting from long-standing hypertension, anemia, volume overload and metabolic disturbances. The present study aims to evaluate ***cardiac changes in CKD*** *patients using* ***Electrocardiography (ECG)*** *and* ***Echocardiography****, which are cost-effective, non-invasive and widely accessible diagnostic tools. This hospital-based observational study was conducted on CKD patients attending the Internal Medicine Department of Rama Medical College Hospital & Research Centre, Hapur, between March 2020 and June 2021. Detailed clinical history, physical examination and laboratory investigations were performed to determine CKD stage based on estimated glomerular filtration rate (eGFR). ECG analysis focused on identifying* ***left ventricular hypertrophy (LVH)****,* ***arrhythmias****,* ***prolonged QT interval****,* ***peaked T waves****,* ***ST-T abnormalities****, and conduction defects commonly associated with electrolyte imbalance. Echocardiographic parameters included* ***left ventricular mass index (LVMI)****,* ***ejection fraction (EF)****,* ***diastolic dysfunction****,* ***regional wall motion abnormalities****, and presence of* ***pericardial effusion****, which is frequently observed in advanced CKD. The study found a high prevalence of LVH, diastolic dysfunction and reduced EF among CKD patients, particularly those in Stage 4 and 5. ECG abnormalities such as peaked T waves and prolonged QT interval were strongly associated with hyperkalemia and uremic state. Echocardiography detected subtle structural abnormalities that were not always evident on ECG, highlighting its importance in early diagnosis. The findings emphasize the need for routine cardiovascular screening in CKD patients to reduce life-threatening complications. Early detection through ECG and echocardiography can aid in prompt management and improve clinical outcomes by addressing potentially reversible factors.*

KEYWORDS:

Chronic Kidney Disease, ECG, Echocardiography, LVH, Diastolic Dysfunction, Cardiac Changes

INTRODUCTION:

Chronic Kidney Disease (CKD) represents a progressive decline in kidney function and is recognized as a major public health problem worldwide. As kidney function deteriorates, multiple systemic complications emerge, most notably cardiovascular disease, which remains the primary cause of mortality in CKD patients. The interrelationship between CKD and cardiovascular dysfunction is complex, involving hemodynamic, metabolic and neurohormonal alterations. CKD leads to **volume overload**, **anemia**, **electrolyte imbalance**, **secondary hyperparathyroidism**, and **chronic inflammation**, all of which contribute to changes in cardiac structure and function. Among these, **left ventricular hypertrophy (LVH)** is one of the earliest detectable abnormalities due to increased afterload and chronic pressure overload. Furthermore, CKD patients often experience **diastolic dysfunction** and **systolic impairment** which progressively worsen with disease severity. Non-invasive cardiac evaluation plays a crucial role in detecting **subclinical cardiac involvement** in CKD. ECG is a simple and readily available tool that can reveal conduction abnormalities, chamber enlargement and electrolyte-induced changes such as **peaked T waves** in hyperkalemia. However, ECG may not detect early structural changes, making echocardiography an essential modality in assessing cardiac anatomy, ventricular thickness, wall motion and functional parameters. Echocardiography provides detailed evaluation of **left ventricular mass index**, **ejection fraction**, **diastolic filling patterns**, and presence of pericardial effusion, which is relatively common in advanced CKD due to uremic pericarditis. Despite significant advances in CKD management, many patients still progress to advanced stages without adequate cardiovascular monitoring. Data from Western Uttar Pradesh, especially rural and semi-urban populations, remain limited, making regional studies essential to understand disease patterns. Early detection of cardiac abnormalities allows clinicians to modify treatment strategies, including better blood pressure control, correction of anemia and electrolyte disorders, and appropriate dialysis timing. This study aims to assess the prevalence and spectrum of cardiac changes in CKD patients using ECG and echocardiography and to correlate findings with CKD stage. The results are expected to enhance understanding of cardiovascular risk in CKD and emphasize the importance of routine cardiac evaluation in these patients.

MATERIALS AND METHODS :

This hospital-based observational study was conducted in the Department of Internal Medicine, Rama Medical College Hospital & Research Centre, Hapur, between 02 March 2020 and 03 June 2021. A total of diagnosed CKD patients aged 18 years and above were enrolled. CKD was classified based on **KDIGO guidelines** using estimated glomerular filtration rate (eGFR). Inclusion criteria included confirmed CKD Stage 2–5 patients willing to undergo ECG and echocardiographic evaluation. Exclusion criteria were acute kidney injury, history of congenital heart disease, prior myocardial infarction, chronic liver disease, malignancy and patients on medications affecting cardiac conduction. After informed consent, demographic details such as age, gender, occupation, socioeconomic status and comorbidities including hypertension, diabetes and dyslipidemia were recorded. Clinical examination included measurement of blood pressure, pulse rate, respiratory rate, pallor, edema, jugular venous pressure and signs of volume overload. Laboratory investigations included complete blood count, renal function tests, electrolytes, calcium, phosphate, parathyroid hormone, lipid profile and ECG-relevant markers like serum potassium. ECG was performed using a standardized 12-lead machine and interpreted by two independent physicians. ECG parameters assessed included **left ventricular hypertrophy criteria (Sokolow-Lyon and Cornell voltage)**, **ST-T changes**, **arrhythmias**, **bundle branch blocks**, **QTc interval**, and **tall peaked T waves** indicative of hyperkalemia. Echocardiography was performed using a 2D echo machine with M-mode, Doppler and tissue Doppler imaging. Parameters measured included **interventricular septal thickness**, **posterior wall thickness**, **left ventricular internal dimensions**, **left ventricular ejection fraction**, **diastolic function (E/A ratio, E/e' ratio)**, **regional wall motion abnormalities**, **valvular abnormalities**, and presence of **pericardial effusion**. LVH was defined based on the LV mass index adjusted for body surface area. Data analysis was performed using SPSS version 25. Continuous variables were expressed as mean ± SD, while categorical variables were presented as percentages. Associations between CKD stage and cardiac parameters were evaluated using chi-square test and ANOVA. Pearson correlation coefficient was used to assess relationships between eGFR, serum electrolytes and cardiac abnormalities. A p-value < 0.05 was considered statistically significant.

RESULTS :

A total number of CKD patients between Stage 2 and Stage 5 were included. The majority were males aged 40–70 years. ECG abnormalities were present in a significant proportion of cases, with **LVH** being the most common finding, followed by ST-T abnormalities,

prolonged QTc interval and arrhythmias. Hyperkalemia-related peaked T waves were frequently observed in Stage 4 and 5 CKD. Echocardiography revealed high prevalence of **diastolic dysfunction**, **LVH**, **reduced ejection fraction**, and **pericardial effusion**. Stage 5 patients showed the highest burden of cardiac abnormalities. LV mass index was significantly elevated in patients with long-standing hypertension and low eGFR. Diastolic dysfunction was present even in early CKD stages, indicating early myocardial involvement. Statistical analysis demonstrated strong correlation between CKD severity and both ECG and echocardiographic abnormalities.

DISCUSSION :

The study showed a high prevalence of structural and functional cardiac abnormalities in CKD patients, consistent with global trends. LVH and diastolic dysfunction were the earliest detectable abnormalities, highlighting chronic pressure overload and metabolic imbalance. ECG abnormalities correlated strongly with electrolyte disturbances, particularly hyperkalemia. Echocardiography proved more sensitive in detecting early changes compared to ECG. Routine cardiovascular monitoring is crucial in CKD management to prevent complications.

CONCLUSION:

CKD patients demonstrate significant cardiac involvement detectable through ECG and echocardiography. LVH, diastolic dysfunction and reduced ejection fraction were the most common findings. ECG abnormalities such as ST-T changes and peaked T waves reflected underlying electrolyte and metabolic disturbances. Early detection of cardiac changes emphasizes the need for integrating routine cardiac evaluation into CKD management protocols to improve outcomes and reduce mortality.

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