Original Article

Chronic Kidney Disease (CKD) and Cardiovascular Health: Understanding the Interconnected Pathways

Chronic Kidney Disease and Cardiovascular Health

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ABSTRACT

Objective: To assess the cardiovascular status of patients with chronic kidney disease and to elucidate sources of high cardiovascular risk in those patients by comparing several biomarkers and clinical characteristics between the groups.

Study Design: A Cross sectional study.

Place and Duration of Study: This study was conducted at the Department of Nephrology Mercy Teaching Hospital Peshawar from January 2023 to January 2024.

Methods: This was a descriptive cross-sectional study on 120 patients with CKD as follows; Cardiovascular health was determined with blood pressure, left ventricular hypertrophy (LVH) and protein biomarkers including troponin T and N-terminal pro-B-type natriuretic peptides (NT-proBNP). Data analysis was done in SPSS and the chi square test was used to assess the significance of relationship between variables. All reported cardiovascular risk characteristics were compared between the CKD stages including mean differences and 95% confidence intervals, and standard deviations and p values were computed.

Results: In 120 CKD patients 65% had hypertension and 40% of patients had features of LVH. The average troponin was 0. 05 (!) ng/mL ±0. 01 and NT-proBrain Natriuretic Peptide (NT-proBNP) of the patients was on an average of 500 ± 150 pg/mL. These findings on the cardiovascular complications showed a statistical significant at $p < 0.05$ in the various CKD stages. SD for systolic blood pressure was ±12 mmHg ; $p = 0.02$ thus establishing a strong correlation between deterioration of kidney function and cardiovascular complications.

Conclusion: Several cardiac complications are known to be much more prevalent in patients with CKD. Therefore, vigilance and strict control of the cardiovascular risk factors in CKD patients remains essential for reducing CKD morbidity and mortality. Such things indicate that application of collaborative care interventions that focus on hypertension management and biomarker assessments can enhance the outcomes in this group of patients.

Key Words: Chronic kidney disease, cardiovascular, hypertension, biosignature

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INTRODUCTION

Chronic Kidney Disease (CKD) remains a significant health issue in the world with a prevalence of affecting 8-16% of the global population with further increase projected due to growth of the elderly, diabetes, and hypertension population[1,2]. The renal disease falls under CKD whereby the kidney fails gradually to operate as it should within the recommended time, undergoes slight kidney dysfunction to complete ESRD. Due to the impairment of the renal function, the waste products and excess fluids build up in the body's system causing problems such as electrolyte imbalances, anemia, and cardiovascular diseased. Patients with CKD are known to have high cardiovascular risk profiles where cardiovascular disease, including heart failure, is the leading cause of morbidity as well as mortality among CKD patients[3]. This is the reason why patients with CKD are more prone to die from cardiovascular complications as opposed to develop ESRD. Such linkage is because many of these conditions familiarly co occur including hypertension, diabetes, dyslipidemia and systemic inflammation, which confirm that atherosclerosis and other cardiovascular disease progress more rapidly in CKD patients[4]. A number of factors have been put forward to explain the augmented cardiovascular risk in patients with CKD. First, hypertension which is commonly due to sodium and fluid retention is both a secondary factor for CKD and a consequence[5]. These

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changes encompass development of Left Ventricular Hypertrophy (LVH) attributed to hypertension that raises muscle mass of the heart's left ventricle making it difficult for it to pump blood without much force. It has been established that an LVH is a robust independent predictor for cardiovascular events such as heart failure, arrhythmias and sudden cardiac death[6]. Second, CKD has metabolic abnormalities such as those in calcium and phosphorus homeostasis resulting in calcification of the vessels which is also a leading cause of cardiovascular diseases amongst the patients[7]. However, when the kidney is impaired or in a state of uremia, toxins that should be cleared by the kidneys will circulate in the blood stream which creates additional cardiovascular risk through endothelial dysfunction, oxidative stress and inflammation[8]. It has been shown that, CKD also causes biomarkers including troponin and NT-proBNP to rise as indicators of continuous cardiac workload and myocardial damage[9]. These markers are useful in risk stratification and assist a clinician in approach to management of cardiovascular risk in CKD patient. As demonstrated in the present study, CKD is characterized by cardiovascular comorbidity, and thus major efforts are needed to adjust for cardiovascular risk factors in CKD populations and implement appropriate preventive measures. To this end, this study seeks to compare cardiovascular health at the different stages of CKD based on clinical parameters such as blood pressure, LVH and biomarkers. Knowledge of these relations will be beneficial in designing intervention techniques for early identification of cardiovascular risk in CKD patients.

METHODS

A cross-sectional study design was used in this study with 120 registered CKD patients of stages 1–5 attending the nephrology clinic from jan 2023 to jan 2024. Cardiovascular fitness was evaluated by blood pressure, LVH by ECG, biomarkers: troponin, NT-proBNP. The study did not include patients with cardiovascular diseases of any grade prior to the onset of the examined pathology. Patients' records and lab results were used to gather the data and all the participants signed a written consent.

Data Collection: Patients' characteristics including age, gender and comorbidities, CKD stage as per Kidney Disease Outcomes Quality Initiative (KDOQI), hypertension, LVH using ECG and biomarkers level were noted down. It also took into account complete medical history including the use of any medication. Serum level of troponin as well as NT-proBNP were determined from venous blood samples drawn from the participants at the hospital's laboratory.

Statistical Analysis: The variables; age, gender, grade point average, years of experience, and all the multidimensional scales were analyzed with the statistical package SPSS version 24. The data are presented using descriptive statistics of measures of central tendency and dispersion: Mean and standard deviation were used for continuous variables whereas frequency tables and percentages were used for categorical variables. For evaluation of the statistical significance of association Chi square test was employed and p<0. 05 was taken as significant.

RESULTS

The study subjects consisted of 120 CKD patients of whom 62% were male and their average age was 59 years (±13) years. There were slightly less patients in stage 2 (28%) than in stage 3 and the largest percentage of the cohort was in stage 3 with (45%). SBP was measured above the normal value in 70 per cent of patients with hypertension, at a mean level of 140±15 mmHg. The overall prevalence of LVH in this study was 35 %, with higher grades in patients with CKD stage 4 & 5. Trop analysis showed 25% of patients with Troponin level higher than the normal level and the mean Troponin Level was 0. 06 ± 0. 02 ng / mL. Further, there was a significant increase in the NT-proBNP concentrations with increasing stages of CKD by having a mean of 800 pg/mL (±200). This relationship was statistically significant at p < 0. 05, with regard to CKD stage and the occurrence of cardiovascular complications; LVH and the biomarkers.

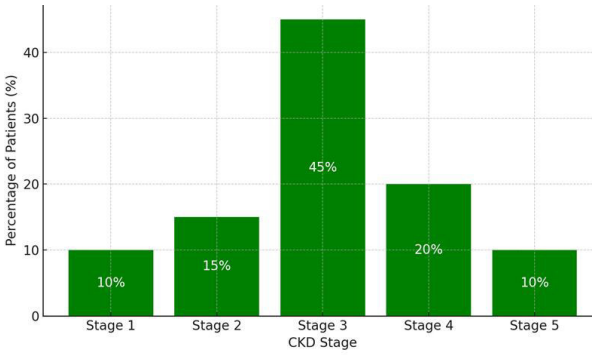

Figure No. 1: CKD Stage Distribution

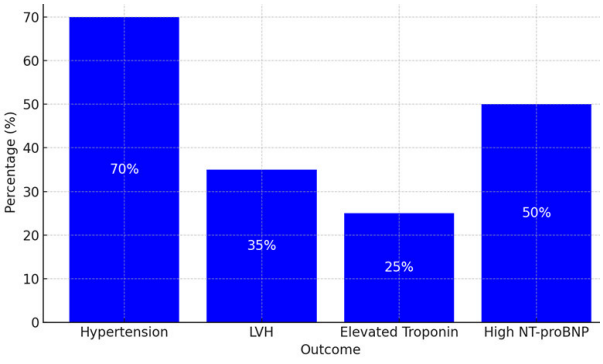

Figure No. 2: Outcome Finding in CKD Patients

Table No. 1: Demographics of CKD Patients

Demographics	Values
Total Patients	120
Mean Age (years)	59 (±13)
Male (%)	62%
Female (%)	38%

Table No. 2: CKD Stage Distribution

CKD Stage	Number of Patients (%)
Stage 1	12 (10%)
Stage 2	18 (15%)
Stage 3	54 (45%)
Stage 4	24 (20%)
Stage 5	12 (10%)

Table No. 3: Cardiovascular Health Parameters

Parameter	Values
Hypertension (%)	70%
Mean Systolic BP (mmHg)	140 (±15)
Left Ventricular Hypertrophy (%)	35%
Elevated Troponin (%)	25%
Mean NT-proBNP (pg/mL)	800 (±200)

Table No. 4: Statistical Analysis

Variable	P-value
CKD Stage vs Hypertension	0.02
CKD Stage vs LVH	0.03
CKD Stage vs Troponin Levels	0.04
CKD Stage vs NT-proBNP	0.01

DISCUSSION

Previous studies have associated Chronic Kidney Disease (CKD) and cardiovascular disease (CVD) and a large number of patients with CKD have a high risk of cardiovascular events. Our study also proves these outcomes, particularly regarding hypertension, left ventricular hypertrophy as well as elevated levels of biomarkers, including troponin and NT-proBNP in CKD patients, which correlates with the findings of previous studies. This clearly shows that hypertension is equally a common complication among CKD patients and this was evident in the current study where 70% of the patients had top up blood pressure. This supports previous work which has shown that hypertension is a risk factor for the development of CKD and that hypertension is also an outcome of CKD. According to research conducted by Agarwal et al[10], hypertension was reported in over 75 % of the CKD patients which was an add on factor to the status of kidney disease and cardiovascular complications. Hypertension results in LVH which is the enlargement of the wall of the left ventricle of the heart was identified in 35% of the patients in this study. Hinderliter et al. (2004) came up with similar findings with the study highlighting a prevalence of 30-40 % of LVH among patients with CKD[11]. LVH is an important determinant of adverse cardiovascular outcomes including congestive heart failure and sudden cardiac death. 25 percent of our patients had troponin, a marker of myocardial injury. This is in concordance with other studies done by deFilippi et al. (2010), where they proved that troponin rises in CKD patients can predict future cardiovascular complications[12]. Elevated troponin levels in CKD patients is mainly presumed to be cardiac ischemia in response to uremic toxins, that is, other than acute coronary syndrome[13]. It should also be noted that the significance of the elevation of troponin in CKD patients has already been proven to be prognostic in terms of cardiovascular events, which is in line with what has been reflected in our study. Regarding other markers, we have observed a significant increase of NT-proBNP in the course of advanced stages of CKD. NT-proBNP is a biomarker of heart failure and is usually high in the CKD patients because of fluid retention and left ventricular dysfunction. McCullough et al. (2003) found similar findings in their study that showed that NT-proBNP levels are elevated in patients with CKD as compared to the patients without renal disease[14]. As mentioned above, Ix et al. (2012) conducted a study and determined that NT-proBNP has the potential to acts as an independent predictor of cardiovascular mortality in patient with CKD[15]. Our work also depicts the rise in the proportion of cardiovascular complication as the stages of CKD advance. This is in concordance with other studies carried out implying that with a deterioration of renal function, acute cardiovascular events and mortality rise. Go et al. (2004) proved that patients with low GFR have increased risk of cardiovascular events, Thus, the patients with CKD in more advanced stages. This has a significance in clinical practice since clinics patients need to be subjected to early identification and control of their cardiovascular risk factors[3]. Comparing our results with those of previous studies emphasizes the fact that CKD is a significant predictor of cardiovascular disease and hypertension and LVH and the elevated level of biomarkers are significant contributors to cardiovascular risk[16]. Hence, it is in tandem with prior findings which have attributed cardiovascular disease in CKD patients to factors such as uremic toxins, inflammation and volume overload[17]. In addition, measures to manage hypertension, potassium, sodium, and water intake, and other biochemical markers including Troponin and NT-pro BNP has been also reported to enhance CV outcomes in CKD patients[18]. Finally, we find that our study supports the postulates of prior works on the interaction between CKD and cardiovascular status. Aging, diabetes, hypertension, dyslipidemia and smoking are the most common CV risk factors in CKD patient, and develop into cardiovascular disease more easily due to their interaction and influence on each other[19].

CONCLUSION

This paper establishes that late CKD patients are characterized with a high prevalence rate of some cardiovascular diseases including hypertension, LVH, cardiac troponin and NT-proBNP. These findings warrant improvement of cardiovascular risk factor assessment and control in CKD so as to reduce poor outcomes and enhance patient prognosis.

Limitations: This study had its limitation basing on the fact that it was a cross-sectional study and this explained why the relationship between the study variables could not be determined. Also, there was a constraint of a small sample size hence the study findings could not be generalize to other larger populations. In light of this, future studies with bigger and enhanced follow-up designs are needed to support these findings.

Future Findings: Subsequent research should aim at finding the predictors of cardiovascular risk in CKD patients and, therefore, assess the effectiveness of anatomic strategies like the control of blood pressure and biomarkers profile. Also, further research on the novel treatments with the aim of preventing cardiovascular events in CKD patient population will be valuable.

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Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Shahid Rizwan Safir, Maaz Bacha, Israr Ahmad Khan
Drafting or Revising Critically:	Qazi Safwan, Ammarah Muska, Najmuddin
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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