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Original Research Article

Impact of Left Ventricular Dysfunction on Renal function and its Pharmacotherapeutic Implications in Patients with Coronary Artery Disease

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Abstract: ***Background:*** To evaluate the association between left ventricular systolic dysfunction and renal function among patients with coronary artery disease and to explore the potential implications for pharmacological management. ***Objective Methods*** This retrospective observational study was conducted at a tertiary care hospital in Kerala, India. Medical records of patients admitted with coronary artery disease between January 2012 and December 2016 were reviewed. A total of 161 patients with complete clinical, echocardiographic, and laboratory data were included. Left ventricular systolic function was categorized as EF <35% and EF ≥35%. Renal dysfunction was assessed using serum creatinine levels and estimated glomerular filtration rate (eGFR). Associations between variables were analyzed using Chi-square test and logistic regression analysis. ***Results*** Among the 161 patients, moderate renal dysfunction was the most common stage (52.6%), followed by mild (24.0%), severe (7.8%), and kidney failure (5.2%). Severe left ventricular dysfunction (EF <35%) was present in 105 patients (65.2%). Patients with reduced ejection fraction showed a higher prevalence of moderate to severe renal dysfunction compared with those with EF ≥35%. Age was significantly associated with renal dysfunction (χ^2 = 30.139, p < 0.001). Logistic regression analysis indicated increased odds of renal dysfunction among patients with reduced ejection fraction (OR = 1.92), although the association did not reach statistical significance (p = 0.074). ***Conclusion*** Left ventricular systolic dysfunction is associated with increased severity of renal dysfunction among patients with coronary artery disease. The coexistence of cardiac and renal dysfunction may influence drug metabolism and therapeutic response, emphasizing the importance of individualized pharmacological management and careful dose adjustment of cardiovascular medications in such patients.

Keywords: Coronary artery disease; Left ventricular dysfunction; Cardiorenal syndrome; Renal dysfunction; Pharmacotherapy; Glomerular filtration rate.

INTRODUCTION

Coronary artery disease (CAD) remains one of the leading causes of morbidity and mortality worldwide and represents a major public health burden in both developed and developing countries. The coexistence of cardiac dysfunction and renal impairment is increasingly recognized as an important determinant of adverse clinical outcomes in patients with cardiovascular disease (1,2). The heart and kidneys are closely interconnected through hemodynamic, neurohormonal, and inflammatory pathways, and dysfunction in one organ can lead to impairment of the other, a phenomenon commonly described as the

cardiorenal syndrome (3).

Left ventricular dysfunction is a common complication in patients with CAD and is associated with poor clinical outcomes, including increased hospitalization, reduced functional capacity, and higher mortality rates (4). Reduced left ventricular ejection fraction (LVEF) leads to decreased cardiac output and renal hypoperfusion, which subsequently activates the renin–angiotensin–aldosterone system and sympathetic nervous system. This activation contributes to sodium and fluid retention, systemic inflammation, and progressive deterioration of renal function (5). These mechanisms further aggravate heart failure and contribute to a vicious cycle between cardiac and renal dysfunction.

Renal dysfunction is frequently observed among patients with cardiovascular disease and has been shown to significantly worsen prognosis. Chronic kidney disease (CKD), defined by reduced glomerular filtration rate (GFR), is associated with increased cardiovascular events, hospitalization, and mortality (6). Several studies have demonstrated that patients with CKD undergoing coronary interventions have higher rates of adverse outcomes compared with those with preserved renal function (7).

Recent evidence also highlights the complex interaction between left ventricular function and renal impairment in patients undergoing coronary interventions. In a large cohort study of patients undergoing percutaneous coronary intervention, Pitaro et al. reported that patients with CKD and reduced LVEF had significantly higher risks of mortality and myocardial infarction compared with those with preserved ventricular function (8). These findings emphasize the importance of ventricular function as a key determinant of outcomes in patients with coronary artery disease and renal dysfunction.

The clinical impact of renal dysfunction in patients with cardiac failure has also been demonstrated in patients undergoing mechanical circulatory support. A systematic review conducted by Ibrahim et al. reported that patients with renal dysfunction had significantly higher mortality after left ventricular assist device (LVAD) implantation compared with patients with normal renal function (9). Similarly, studies evaluating patients with acute coronary syndromes and heart failure with preserved ejection fraction have shown that renal dysfunction is strongly associated with diastolic dysfunction and adverse cardiovascular outcomes (10).

In addition to functional cardiac impairment, structural cardiac changes may also occur in the presence of renal dysfunction. Khan et al. demonstrated that declining renal function was associated with increased left ventricular mass index and left ventricular remodeling in patients with renal artery stenosis (11). These findings suggest that renal dysfunction may contribute to both functional and structural cardiac abnormalities.

Despite growing recognition of the cardiorenal interaction, limited data are available regarding the relationship between left ventricular dysfunction and renal impairment specifically among patients with CAD in routine clinical settings. Understanding this relationship is important for risk stratification, early identification of high-risk patients, and implementation of appropriate therapeutic interventions.

Therefore, the present study was conducted to determine the impact of left ventricular dysfunction (EF <35%) on the severity of renal function among patients with coronary artery disease.

METHODOLOGY

Study Design

This study was a retrospective observational hospital-based study conducted to evaluate the association between left ventricular systolic dysfunction and renal dysfunction among patients diagnosed with coronary artery disease (CAD).

Study Setting and Period

The study was conducted in a tertiary care teaching hospital in Kerala, India. Medical records of patients admitted with coronary artery disease between January 2012 and December 2016 were retrospectively reviewed. All eligible cases within this five-year period were included for analysis.

Study Population

The study population consisted of adult patients aged 18 years and above admitted with a confirmed diagnosis of coronary artery disease. Diagnosis was established based on clinical presentation, electrocardiographic findings, cardiac biomarkers, echocardiography, and/or coronary angiographic evidence.

A total of 161 patients with complete clinical, echocardiographic, and laboratory records were included in the final analysis.

Inclusion Criteria

Patients were included if they met the following criteria:

- Age ≥18 years
- Confirmed diagnosis of coronary artery disease
- Availability of echocardiographic assessment of left ventricular ejection fraction (LVEF)
- Availability of renal function parameters including serum creatinine

Exclusion Criteria

Patients were excluded if they had:

- Congenital heart disease
- Primary non-ischemic cardiomyopathy
- Significant primary valvular heart disease
- Incomplete clinical or laboratory records
- Repeated hospital admissions during the study period (only the first admission was considered)

Data Collection

Data were obtained from inpatient case records, laboratory reports, echocardiography reports, and discharge summaries. A structured data extraction format was used to collect relevant variables including demographic characteristics, comorbidities, cardiac function parameters, and renal function indicators.

Study Variables

Demographic Variables

- Age
- Gender

Age was categorized into four groups:

- <50 years
- 50–65 years
- 65–75 years
- >75 years

Clinical Variables

The following comorbid conditions were recorded based on documented diagnosis or treatment history:

- Diabetes mellitus (DM)
- Hypertension (HTN)
- Smoking status
- Dyslipidemia
- Chronic obstructive pulmonary disease (COPD

Cardiac Function Assessment

Left ventricular systolic function was assessed using two-dimensional transthoracic echocardiography at the time of admission.

Patients were categorized into two groups based on left ventricular ejection fraction:

- Severe LV dysfunction: EF <35%
- Preserved/moderate LV function: EF ≥35%

Renal Function Assessment

Renal function was evaluated using:

- Serum creatinine levels
- Estimated Glomerular Filtration Rate (eGFR)

The eGFR was calculated using standard formulae based on serum creatinine and age.

Renal dysfunction was categorized according to CKD stages based on eGFR:

CKD Stage	eGFR (mL/min/1.73m²)	Interpretation
Stage 1	≥90	Normal
Stage 2	60–89	Mild CKD
Stage 3	30–59	Moderate CKD
Stage 4	15–29	Severe CKD
Stage 5	<15	Kidney failure

Additionally, renal dysfunction severity was categorized based on serum creatinine levels into mild, moderate, severe, and high/very severe categories for comparative analysis.

Outcome Measures

The primary outcome of interest was:

Association between left ventricular systolic dysfunction (EF <35%) and severity of renal dysfunction measured using serum creatinine categories and estimated glomerular filtration rate.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.

- Continuous variables were summarized as mean ± standard deviation.
- Categorical variables were expressed as frequencies and percentages.

Associations between categorical variables were evaluated using:

- Chi-square test (χ^2)
- Fisher's exact test, where appropriate.

To identify independent predictors of renal dysfunction, binary logistic regression analysis was performed including variables such as:

- Left ventricular ejection fraction
- Age category
- Diabetes mellitus

- Hypertension
- Smoking status
- Dyslipidemia

Results were presented as odds ratios (OR) with 95% confidence intervals (CI).
A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of the hospital. As the study was retrospective and based on review of medical records, the requirement for informed consent was waived. Patient confidentiality was maintained by de-identifying all patient data prior to analysis.

RESULTS

A total of 161 patients with confirmed coronary artery disease (CAD) were included in the study based on the availability of complete demographic and clinical information. However, the sample size varied across different analyses due to the availability of specific laboratory parameters required for renal function assessment. For analyses involving serum creatinine categories, all 161 patients had complete creatinine values and were therefore included.

For analyses based on estimated glomerular filtration rate (eGFR), only 154 patients had complete data necessary for eGFR calculation, resulting in a slightly smaller sample size in Tables 3 and 4. In the logistic regression analysis evaluating predictors of moderate–severe renal dysfunction (eGFR <60 mL/min/1.73 m²), only patients with complete data for all independent variables included in the regression model were analyzed. Consequently, the effective sample size was reduced due to listwise exclusion of cases with missing values, which is a standard statistical approach in multivariable regression analysis.

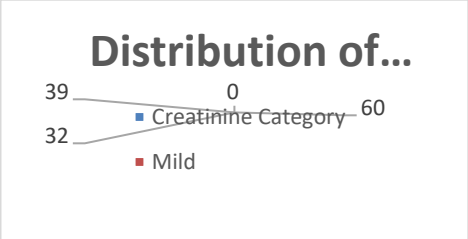
Patients with incomplete laboratory or clinical data were excluded only from the specific analyses where those variables were required but were retained in other analyses where complete information was available.

Table 1: Baseline Clinical Characteristics of the Study Population (n = 161)

Variable	Frequency (n)	Percentage (%)
Diabetes Mellitus	109	67.7
Hypertension	96	59.6
Dyslipidemia	30	18.6
COPD	11	6.8
Hypothyroidism	10	6.2
Hyperuricemia	10	6.2
Smokers	5	3.1
Atrial Fibrillation	11	6.8
Recurrent Admission	39	24.2
Mortality	32	19.9

Among the 161 CAD patients, diabetes mellitus (67.7%) and hypertension (59.6%) were the most common comorbidities. Dyslipidemia was observed in 18.6% of patients. Approximately 19.9% of the patients experienced mortality, while 24.2% had recurrent hospital admissions, highlighting the significant burden of cardiovascular complications among the study population.

Fig 1: Distribution of Renal Dysfunction Severity Among CAD Patients



Renal dysfunction was highly prevalent among CAD patients. Mild renal impairment accounted for the largest proportion (37.3%), followed by severe renal dysfunction (24.2%). Approximately 18.6% of patients had very severe renal impairment, indicating substantial renal involvement among individuals with CAD.

Table 2 : Association Between Left Ventricular Dysfunction and Renal Dysfunction Based on Serum

Creatinine Categories (n = 161)

Creatinine Category	EF <35% n (%)	EF ≥35% n (%)	Total n (%)	p-value, χ^2
Mild	33 (31.4)	27 (48.2)	60 (37.3)	**p-value 0.069 χ^2=7.078**
Moderate	25 (23.8)	7 (12.5)	32 (19.9)	
Severe	24 (22.9)	15 (26.8)	39 (24.2)	
High / Very Severe	23 (21.9)	7 (12.5)	30 (18.6)	
Total	**105 (65.2)**	**56 (34.8)**	**161 (100)**	

Patients with severe left ventricular dysfunction (EF <35%) demonstrated a higher proportion of moderate to very severe renal dysfunction compared with those having EF ≥35%. Although the association approached statistical significance (χ^2 = 7.078, p = 0.069), it did not reach the conventional significance threshold. However, the findings suggest a clinical trend indicating worsening renal function among patients with reduced ejection fraction, supporting the concept of cardiorenal interaction in CAD patients.

Table 3 Association Between Left Ventricular Dysfunction and Renal Dysfunction Based on eGFR Categories (n = 154)

eGFR Category	EF <35% n (%)	EF ≥35% n (%)	Total n (%)	p-value,χ^2
≥90 (Stage 1 – Normal)	10 (9.8)	6 (11.5)	16 (10.4)	**p-value=0.099 χ^2=7.815**
60–89 (Stage 2 – Mild CKD)	19 (18.6)	18 (34.6)	37 (24.0)	
30–59 (Stage 3 – Moderate CKD)	56 (54.9)	25 (48.1)	81 (52.6)	
15–29 (Stage 4 – Severe CKD)	11 (10.8)	1 (1.9)	12 (7.8)	
<15 (Stage 5 – Kidney Failure)	6 (5.9)	2 (3.8)	8 (5.2)	
Total	**102 (66.2)**	**52 (33.8)**	**154 (100)**	

Among patients with EF <35%, the majority had Stage 3 CKD (54.9%), followed by Stage 2 CKD (18.6%). Severe renal dysfunction (Stage 4 CKD) was more common among patients with reduced EF (10.8%) compared with EF ≥35% (1.9%), suggesting worsening renal function among individuals with severe cardiac dysfunction. However, the association did not reach statistical significance (p = 0.099).

Table 4: Association Between Age Categories and Renal Dysfunction Based on eGFR (n = 154)

Age Group	Mild n (%)	Moderate n (%)	Severe n (%)	High / Very Severe n (%)	Total n (%)	p-value, χ^2
<50 years	1 (9.1)	8 (72.7)	2 (18.2)	0 (0.0)	11 (6.8)	**p-value=<0.001, χ^2=30.139**
50–65 years	14 (25.5)	11 (20.0)	16 (29.1)	14 (25.5)	55 (34.2)	
65–75 years	31 (47.7)	10 (15.4)	15 (23.1)	9 (13.8)	65 (40.4)	
>75 years	14 (46.7)	3 (10.0)	6 (20.0)	7 (23.3)	30 (18.6)	
Total	**60 (37.3)**	**32 (19.9)**	**39 (24.2)**	**30 (18.6)**	**161 (100)**	

Stage 3 CKD was the most common renal impairment across all age groups. Although renal dysfunction appeared to increase with advancing age, the association between age category and CKD stage did not reach statistical significance (p = 0.067).

Table 5: Multivariable Logistic Regression Analysis for Predictors of Moderate–Severe Renal Dysfunction (eGFR <60)

Variable	B	SE	χ^2	p-value	Adjusted OR	95% CI
EF <35%	0.654	0.366	3.182	0.074	1.92	0.94 – 3.94
Age category	-0.362	0.218	2.750	0.097	0.70	0.45 – 1.07
Diabetes Mellitus	-0.845	0.463	3.324	0.068	0.43	0.17 – 1.07
Hypertension	0.263	0.433	0.371	0.543	1.30	0.56 – 3.04
Smoking	-1.113	0.975	1.301	0.254	0.33	0.05 – 2.22
Dyslipidemia	-0.168	0.453	0.138	0.710	0.85	0.35 – 2.05
−2 Log likelihood			191.845			
Cox & Snell R^2			0.073			
Nagelkerke R^2			0.101			
Overall classification accuracy			68.9%			

Model Performance

Multivariable logistic regression demonstrated that EF <35% was associated with nearly twofold higher odds of moderate–severe CKD, although statistical significance was not achieved. Age and diabetes showed borderline associations, whereas hypertension, smoking, and dyslipidemia were not significant predictors.

The study demonstrated a high prevalence of renal dysfunction among patients with coronary artery disease. Patients with reduced left ventricular ejection fraction tended to have more severe renal impairment, suggesting a potential cardiorenal interaction, although statistical significance was not reached. Age and diabetes mellitus also showed trends toward association with renal dysfunction, emphasizing their role as important contributors to renal impairment in CAD patients.

DISCUSSION

The present study evaluated the association between left ventricular dysfunction and renal dysfunction among patients with coronary artery disease. The findings demonstrated a high prevalence of renal impairment in CAD patients, highlighting the clinical importance of the cardiorenal interaction in this population.

In the present study, diabetes mellitus and hypertension were the most common comorbidities among patients with CAD. These findings are

consistent with previous studies that reported metabolic and vascular risk factors as major contributors to both cardiovascular and renal diseases. Diabetes mellitus is a well-established cause of chronic kidney disease and contributes to accelerated vascular injury and microvascular damage in patients with coronary artery disease.

The analysis of renal dysfunction based on serum creatinine levels revealed that patients with severe left ventricular dysfunction (EF <35%) had a higher proportion of moderate to very severe renal impairment compared with patients having preserved ventricular function. Although the association did not reach statistical significance, a clear trend toward worsening renal function in patients with reduced ejection fraction was observed. This relationship supports the concept of cardiorenal syndrome, in which impaired cardiac function leads to reduced

renal perfusion, activation of neurohormonal pathways, and progressive renal dysfunction.

A similar relationship between ventricular dysfunction and renal impairment has been reported in previous cardiovascular studies. Pitaro et al. demonstrated that patients with chronic kidney disease undergoing percutaneous coronary intervention who had reduced left ventricular ejection fraction experienced significantly higher risks of mortality and myocardial infarction compared with those with preserved ventricular function (1). These findings emphasize the clinical importance of ventricular dysfunction in determining outcomes among patients with renal impairment and coronary artery disease.

The present study also assessed renal dysfunction using estimated glomerular filtration rate (eGFR), which is considered a more accurate indicator of kidney function. The findings revealed that Stage 3 chronic kidney disease was the most prevalent category among CAD patients, and patients with reduced ejection fraction had a greater proportion of advanced CKD stages. Although the association between EF and CKD stage did not reach statistical significance, the observed pattern suggests that reduced ventricular function may contribute to deterioration in renal function.

Age was another important factor associated with

renal dysfunction in the present study. Older patients demonstrated a higher prevalence of moderate to severe renal impairment. This finding is consistent with previous studies showing that renal function declines progressively with age due to structural and functional changes in the kidneys, including reduced nephron number, vascular sclerosis, and decreased renal perfusion.

Diabetes mellitus also showed a borderline association with moderate to severe CKD in the multivariable logistic regression analysis. Diabetes is known to cause progressive nephropathy through mechanisms such as glomerular hyperfiltration, oxidative stress, and inflammatory activation. These pathophysiological mechanisms may accelerate renal impairment in patients with cardiovascular disease.

The association between cardiac dysfunction and renal impairment has also been demonstrated in patients with acute coronary syndromes and heart failure with preserved ejection fraction. Ismayilov et al. reported that renal dysfunction was present in more than 80% of patients with non-ST segment elevation acute coronary syndrome and HFpEF, and renal function indicators were significantly associated with parameters of left ventricular diastolic dysfunction (10). Their study further demonstrated that reduced glomerular filtration rate and increased microalbuminuria were significant predictors of rehospitalization, recurrent acute coronary syndrome, and progression of heart failure.
Similarly, structural cardiac changes associated with renal dysfunction have been described in patients with renovascular disease. Khan et al. found that declining renal function was significantly associated with increased left ventricular mass index and left ventricular remodeling in patients with renal artery stenosis (11). Their study demonstrated that patients with advanced CKD stages exhibited higher left ventricular mass and a higher prevalence of concentric hypertrophy, suggesting that renal dysfunction contributes to structural and functional cardiac alterations.

The interaction between cardiac dysfunction and renal disease has also been observed in patients with advanced heart failure requiring mechanical circulatory support. A systematic review by Ibrahim et al. showed that patients with renal dysfunction undergoing left ventricular assist device implantation had significantly higher mortality compared with those with preserved renal function (2). The authors concluded that glomerular filtration rate is an important prognostic marker for risk stratification in patients with advanced heart failure.

Taken together, these findings support the concept that cardiac and renal dysfunction frequently coexist and mutually exacerbate disease progression. Reduced cardiac output, venous congestion, neurohormonal activation, and systemic inflammation contribute to worsening renal function in patients with cardiovascular disease. Conversely, renal dysfunction may lead to volume overload, electrolyte imbalance, and neurohormonal activation, further aggravating cardiac dysfunction.

Despite the trends observed in the present study, the association between left ventricular dysfunction and renal impairment did not reach statistical significance. This may be attributed to the relatively limited sample size and the presence of multiple confounding clinical factors among CAD patients. Nevertheless, the results highlight the importance of evaluating renal function in patients with coronary artery disease, particularly those with reduced ventricular function.

The coexistence of left ventricular dysfunction and renal impairment has important implications for pharmacological management in patients with coronary artery disease. Renal dysfunction can alter the pharmacokinetics and pharmacodynamics of several cardiovascular medications, including antiplatelet agents, anticoagulants, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and diuretics. Reduced renal clearance may lead to drug accumulation and increased risk of adverse drug reactions. Furthermore, decreased cardiac output associated with severe left ventricular dysfunction may further compromise renal perfusion and drug distribution. Therefore, patients with combined cardiac and renal dysfunction require careful monitoring of renal function, individualized drug dosing, and close therapeutic surveillance to optimize treatment outcomes and minimize medication-related complications.

CONCLUSION

The present study demonstrates a significant relationship between left ventricular systolic dysfunction and renal impairment in patients with coronary artery disease. Patients with reduced ejection fraction showed a higher prevalence of moderate to severe renal dysfunction, highlighting the presence of a cardiorenal interaction in this population. Age was also found to be significantly associated with worsening renal function.

These findings emphasize the importance of routine assessment of renal function in patients with coronary artery disease and impaired ventricular function. From a clinical pharmacology perspective, renal dysfunction may influence drug metabolism, therapeutic efficacy, and safety of cardiovascular medications. Therefore, individualized pharmacotherapy, appropriate dose adjustments, and careful monitoring of renal function are essential to optimize treatment outcomes and reduce the risk of adverse drug reactions in this high-risk patient

population.

CONFLICT OF INTEREST: Nil

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