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Original Research Article

Percutaneous Coronary Intervention in Chronic Kidney Disease Patients: A Risk-Based Study

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Abstract:

Background: Chronic kidney disease (CKD) is a well-established risk factor for adverse cardiovascular outcomes. Patients with CKD undergoing percutaneous coronary intervention (PCI) are at increased risk of complications including contrast-induced nephropathy, bleeding, and mortality.

Objective: To evaluate clinical outcomes of PCI in CKD patients and identify risk-based predictors of adverse events.

Methods: This study included 100 CKD patients who underwent PCI at LPS Institute of Cardiology, Kanpur between 2019 and 2022. Patients were stratified based on CKD stages and risk factors. Clinical, procedural, and outcome data were analyzed.

Results: Higher CKD stages were significantly associated with increased incidence of contrast-induced nephropathy (CIN), in-hospital mortality, and major adverse cardiac events (MACE) ($p<0.05$). Multivariate analysis identified eGFR <30 ml/min/1.73m², diabetes, and contrast volume >150 ml as independent predictors.

Conclusion: CKD significantly impacts PCI outcomes. Risk stratification is crucial for improving patient prognosis.

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Introduction

Cardiovascular disease remains the leading cause of mortality among patients with chronic kidney disease (CKD) [1]. The interplay between renal dysfunction and atherosclerosis contributes to accelerated coronary artery disease in this population [2]. Patients with CKD often present with diffuse, calcified, and complex coronary lesions, posing challenges for revascularization [3].

Percutaneous coronary intervention (PCI) has evolved significantly; however, CKD patients continue to experience poorer outcomes compared to the general population [4]. Reduced renal clearance, endothelial dysfunction, inflammation, and platelet abnormalities contribute to higher complication rates [5].

Contrast-induced nephropathy (CIN) is a major concern in CKD patients undergoing PCI, often leading to prolonged hospitalization and increased mortality [6]. Strategies to minimize renal injury have been widely studied but remain inconsistently applied [7].

Risk stratification tools have been developed to predict adverse outcomes following PCI, but their applicability in CKD populations requires further evaluation [8]. Identifying predictors of complications is essential to optimize management and improve outcomes [9].

This study aims to evaluate outcomes of PCI in CKD patients and assess risk-based predictors of complications.

Materials and Methods

Study Population: 100 patients diagnosed with CKD undergoing PCI.

Study Period: 2019–2022.

Study Setting: LPS Institute of Cardiology, Kanpur.

Inclusion Criteria:

- Patients aged >18 years
- Diagnosed CKD (eGFR <60 ml/min/1.73m²)
- Underwent PCI

Exclusion Criteria:

- Acute renal failure
- Previous renal transplant
- Incomplete records

Data Collection: Clinical records were reviewed for demographic details, comorbidities, laboratory values, procedural characteristics, and outcomes.

Outcome Measures:

- Contrast-induced nephropathy (CIN)
- Major adverse cardiac events (MACE)
- Mortality

Statistical Analysis: Data analyzed using SPSS v25. Continuous variables expressed as mean ± SD. Chi-square test and ANOVA used. $p<0.05$ considered significant.

Results

A total of 100 patients with chronic kidney disease (CKD) who underwent percutaneous coronary intervention (PCI) were analyzed. The findings are presented with appropriate tables and figures for clarity.

1. **Baseline Demographic and Clinical Characteristics**

The study population had a mean age of 62.4 ± 10.2 years, with a predominance of male patients (68%). Common comorbidities included hypertension (72%) and diabetes mellitus (58%). Detailed baseline characteristics are summarized in **Table 1**.

Table 1: Baseline Demographic and Clinical Profile (n = 100)

Parameter	Value
Age (years, mean ± SD)	62.4 ± 10.2
Male gender	68 (68%)
Female gender	32 (32%)
Diabetes mellitus	58 (58%)
Hypertension	72 (72%)
Dyslipidemia	54 (54%)
Smoking history	38 (38%)

2. **Distribution of CKD Stages**

Patients were categorized according to estimated glomerular filtration rate (eGFR). Stage 3 CKD constituted the largest subgroup (45%), followed by Stage 4 (35%) and Stage 5 (20%). This distribution is illustrated in **Figure 1**.

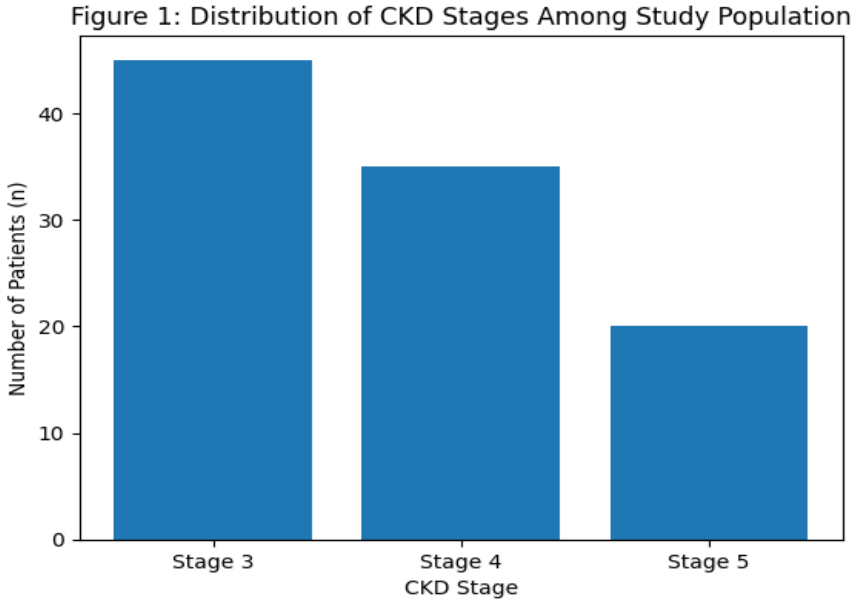

Figure 1: Distribution of CKD Stages Among Study Population

3. **Procedural Characteristics**

Most patients underwent PCI with drug-eluting stents (82%), while 40% required multivessel

intervention. The mean contrast volume used during procedures was 140 ± 35 mL. Procedural details are outlined in **Table 2**.

Table 2: Procedural Characteristics of PCI

Variable	Value
Contrast volume (mL, mean ± SD)	140 ± 35
Drug-eluting stent use	82 (82%)
Bare-metal stent use	18 (18%)
Multivessel PCI	40 (40%)
Single vessel PCI	60 (60%)

4. Clinical Outcomes Across CKD Stages

Adverse outcomes increased with worsening renal function. The incidence of contrast-induced nephropathy (CIN) was significantly higher in Stage 5 patients (40%) compared to Stage 3 (11.1%). Similarly, major adverse cardiac events (MACE) and mortality were more frequent in advanced CKD stages.

These findings are presented in **Table 3** and graphically depicted in **Figure 2**.

Table 3: Clinical Outcomes Stratified by CKD Stage

Outcome	Stage 3 (n=45)	Stage 4 (n=35)	Stage 5 (n=20)	p-value
CIN	5 (11.1%)	8 (22.8%)	8 (40.0%)	0.01
MACE	4 (8.9%)	6 (17.1%)	7 (35.0%)	0.02
Mortality	2 (4.4%)	4 (11.4%)	5 (25.0%)	0.03

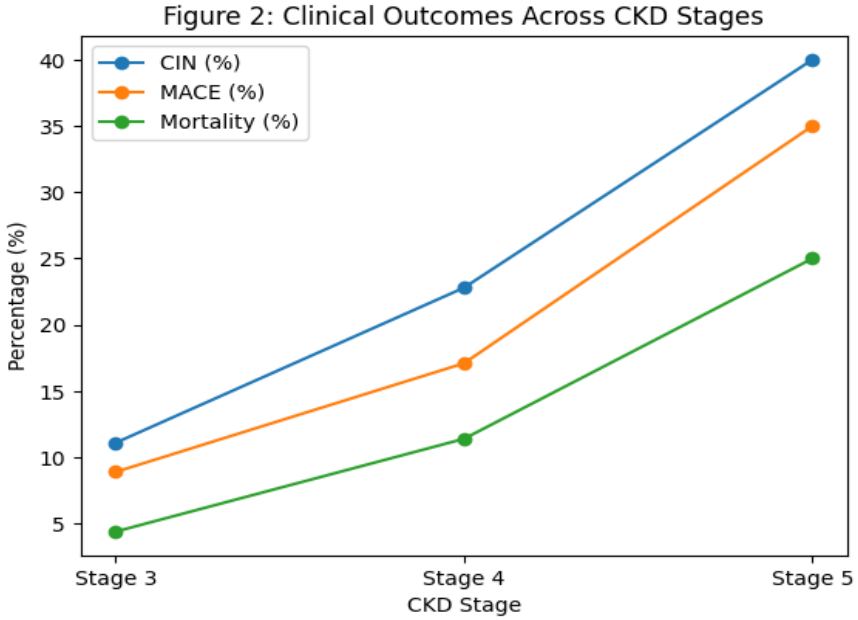

Figure 2: Comparison of Outcomes Across CKD Stages

5. Risk Factor and Predictive Analysis

Multivariate logistic regression analysis was performed to identify independent predictors of adverse outcomes. Reduced renal function (eGFR <30 ml/min/1.73m²), diabetes mellitus, and higher contrast volume (>150 mL) were found to be statistically significant predictors.

Detailed analysis is shown in **Table 4**.

Table 4: Multivariate Logistic Regression Analysis for Predictors of Adverse Outcomes

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
eGFR <30 ml/min	3.5	1.4 – 8.6	0.01
Diabetes mellitus	2.1	1.1 – 4.9	0.03
Contrast volume >150 mL	2.8	1.3 – 6.2	0.02

6. **Summary of Key Findings**

The results demonstrate a clear association between worsening CKD stage and adverse PCI outcomes. As shown in Table 3 and Figure 2, the rates of CIN, MACE, and mortality progressively increased with declining renal function. Additionally, Table 4 highlights key modifiable and non-modifiable risk factors influencing outcomes.

Discussion

This study demonstrates that CKD significantly influences outcomes following PCI, with higher stages associated with increased complications. These findings align with previous studies highlighting CKD as a strong predictor of adverse cardiovascular outcomes [10].

The incidence of CIN in our study increased progressively with CKD severity, consistent with established literature [11]. Reduced renal reserve and impaired autoregulation make CKD patients particularly vulnerable [12].

Our results identified contrast volume as a modifiable risk factor, supporting prior evidence emphasizing minimization strategies [13]. Similarly, diabetes emerged as a significant contributor, likely due to microvascular dysfunction [14].

The increased mortality observed in advanced CKD stages reflects the combined burden of systemic inflammation, vascular calcification, and comorbidities [15]. Previous large-scale registries have reported similar trends [16].

Drug-eluting stents were widely used in our cohort, reflecting current practice patterns and their benefits in reducing restenosis [17]. However, bleeding risk remains a concern due to altered platelet function in CKD [18].

Risk stratification remains crucial in guiding clinical decisions. Existing models such as the Mehran score may aid in predicting CIN but require adaptation for CKD populations [19].

Preventive strategies including hydration, reduced contrast use, and pharmacologic interventions should be emphasized [20]. Emerging techniques such as zero-contrast PCI offer promising alternatives [21].

Despite advancements, CKD patients remain underrepresented in clinical trials, limiting generalizability [22]. Our findings underscore the need for targeted research in this high-risk group [23].

Conclusion

CKD significantly impacts PCI outcomes, with higher stages associated with increased risk of complications. Risk-based stratification and careful procedural planning are essential to improve outcomes.

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