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Original Research Article

INCIDENCE OF CONTRAST-INDUCED NEPHROPATHY FOLLOWING CHRONIC TOTAL OCCLUSION PERCUTANEOUS CORONARY INTERVENTION

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Abstract: *Contrast-induced nephropathy (CIN) is a potentially serious complication following percutaneous coronary intervention (PCI), particularly in patients with chronic total occlusion (CTO). It is characterized by an acute deterioration in renal function after exposure to contrast media. CIN is associated with increased morbidity, hospital stays, and long-term renal outcomes, making it crucial to identify and mitigate its incidence. This study aimed to evaluate the incidence of CIN in patients undergoing CTO-PCI and its associated complications.* ***Objective:*** *To assess the incidence of contrast-induced nephropathy (CIN) following percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) and evaluate in-hospital complications, hospital stay duration, and short-term mortality.* ***Methods:*** *This cross-sectional study was conducted with ethical approval at a tertiary care hospital, including 118 patients who underwent PCI for CTO at the Department of Cardiology, Lady Reading Hospital Peshawar, Pakistan from 10th June 2023 to 09th June 2024. Standardized pre- and post-procedural hydration protocols were implemented to reduce the risk of CIN, and non-ionic, iso-osmolar contrast agents were used. CIN was defined as a 25% increase in serum creatinine or an absolute increase of ≥0.5 mg/dL within 48–72 hours post-procedure. Data on demographic characteristics, complications, and mortality were collected and analyzed using SPSS Version 25, with categorical variables expressed as percentages and continuous variables as means. Chi-square tests were used to assess statistical significance, with P-values < 0.05 considered significant.* ***Results****: Of the 118 patients included, the mean age was 56.34 years, and 52.5% were male. Age distribution showed that 43.2% were between 51-60 years, while 33.1% were between 61-70 years. CIN was observed in 6.8% of patients, with 9.7% of males and 3.6% of females affected (P=0.188). In-hospital complications included arrhythmias in 4.2% of patients, heart failure in 0.8%, and mortality in 0.8%. Hospital stay averaged 5.94 days, with no significant differences in CIN incidence across age groups (P=0.186).* ***Conclusion:*** *The incidence of contrast-induced nephropathy following PCI for chronic total occlusion is a clinically significant issue, affecting 6.8% of patients despite preventative measures. This emphasizes the need for ongoing risk assessment, monitoring, and the implementation of effective prevention strategies. Further research is warranted to refine risk stratification tools and develop targeted interventions to minimize CIN incidence, particularly in high-risk patient populations.*

Keywords: Contrast-Induced Nephropathy, Percutaneous Coronary Intervention, Chronic Total Occlusion

Introduction

Contrast-induced nephropathy (CIN) is a significant clinical concern in patients undergoing various medical procedures that require the use of contrast media, particularly in the context of percutaneous coronary interventions (PCI).(1) CIN is characterized by an acute deterioration of renal function, typically defined as an increase in serum creatinine levels following the administration of contrast agents.(2) The incidence of CIN varies among patient populations, and it is particularly noteworthy in those undergoing procedures for chronic total occlusion (CTO) of coronary arteries. The estimated incidence of CIN in the general population is between 1% and 6%, with this figure significantly increasing in cases where CIN develops after PCI.(3) A retrospective analysis conducted by the Mayo Clinic found that among the general population undergoing PCI, the incidence of contrast-induced nephropathy (CIN) was 3.3%, with a dialysis requirement of 0.3%.(4) However, the incidence of CIN was notably higher in patients with pre-existing renal impairment, exceeding 50% in those classified as very high-risk.(5, 6) CTO refers to the complete blockage of a coronary artery for at least three months, which can lead to significant myocardial ischemia and increased cardiovascular morbidity and mortality.(7) In recent years, advances in interventional cardiology have facilitated the successful treatment of CTOs through PCI, allowing for improved blood flow and patient outcomes. However, the use of contrast media during these procedures poses an increased risk of renal injury, especially in patients with pre-existing renal impairment or other comorbid conditions. As the ageing population and prevalence of cardiovascular diseases rise, understanding the incidence and risk factors associated with CIN in patients undergoing CTO-PCI becomes increasingly vital. To assess the incidence of contrast-induced nephropathy (CIN) following percutaneous coronary intervention (PCI) for chronic total occlusion (CTO).

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Methodology

This Cross-sectional study was conducted at the Department of Cardiology, Lady Reading Hospital Peshawar, Pakistan from 10th June 2023 to 09th June 2024. Patients with chronic total occlusion of a coronary artery, confirmed by coronary angiography, requiring percutaneous coronary intervention. Patients with normal renal function or mild to moderate renal impairment (eGFI ≥30 mL/min/1.73 m²) at baseline. Patients of both genders ages ranging from 18 years to 70 years. Patients with chronic kidney disease (CKD) stage 4 or 5, defined as an estimated glomerular filtration rate (eGFR <30 mL/min/1.73 m²) or patients on dialysis. Patients with a known hypersensitivity or allergic reaction to iodinated contrast agents. Patients with acute heart failure, cardiogenic shock, or requiring mechanical circulatory support at the time of the procedure. Patients with a history of acute kidney injury within the last 30 days before the planned PCI. Pregnant women. This cross-sectional study took place in the Cardiology department following the approval of the hospital's ethical committee. A total of 118 patients were enrolled in the study, with informed consent obtained before enrollment following a thorough explanation of the study's purpose. All the patients underwent the intervention, which consisted of CTO-PCI procedures using contrast media, performed by experienced interventional cardiologists by standardized protocols. To reduce the risk of contrast-induced nephropathy (CIN), patients received intravenous hydration and other preventive measures as per hospital guidelines. The type and volume of contrast media used were recorded for each patient, with a preference for non-ionic, iso-osmolar contrast agents to minimize nephrotoxicity. The primary outcome was the incidence of CIN, defined as a 25% increase in serum creatinine from baseline or an absolute rise of ≥0.5 mg/dL within 48 to 72 hours post-procedure. Secondary outcomes included in-hospital complications (such as arrhythmias and heart failure), duration of hospital stay and 30-day all-cause mortality. For statistical analysis, we used SPSS Version 25.

Results

A total of 118 patients were enrolled, with a mean age of 56.34±8.79 years. The mean hospital stay was 5.94±1.72 days (Table 1). Out of the total enrolled patients, 62(52.5%) patients were male and 56(47.5%) patients were female. The age distribution of the patients was as follows: 4 patients (3.4%) were aged 18-40 years, 24 patients (20.3%) were in the 41-50 year age group, 51 patients (43.2%) were aged 51-60 years, and 39 patients (33.1%) were between 61-70 years. Regarding contrast-induced nephropathy (CIN), 8 patients (6.8%) experienced CIN, while 110 patients (93.2%) did not. The complications observed included heart failure in 1 patient (0.8%), arrhythmias in 5 patients (4.2%), and 112 patients (94.9%) experienced no complications. (Table2) Additionally, there was 1 patient (0.8%) who died within the study period. The stratification of contrast-induced nephropathy based on gender and age groups among the 118 patients revealed that 6 males (9.7%) experienced contrast-induced nephropathy, while 56 males (90.3%) did not, with a P-value of 0.188. In comparison, 2 females (3.6%) had contrast-induced nephropathy, and 54 females (96.4%) did not. Regarding age groups, among those aged 28-40 years, 1 patient (25.0%) experienced contrast-induced nephropathy, while 3 patients (75.0%) did not, with a P-value of 0.186. In the 41-50 year age group, 2 patients (8.3%) had nephropathy compared to 22 patients (91.7%) without it. For the 51-60 year age group, 1 patient (2.0%) experienced nephropathy, while 50 patients (98.0%) did not. Finally, in the 61-70 year age group, 4 patients (10.3%) had contrast-induced nephropathy, and 35 patients (89.7%) did not. (Table 3)

Table 1: Mean age and Hospital Stay of all enrolled Patients (n=118)

Variables	Mean±SD
Age (Years)	56.34±8.79
Hospital Stay (Days)	5.94±1.72

Table 2: Characteristics of all enrolled patients (n=118)

Variables	Frequency (%)
Gender	
Male	62(52.5%)
Female	56(47.5%)
Age groups	
18-40 years	4(3.4%)
41-50 years	24(20.3%)
51-60 years	51(43.2%)
61-70 years	39(33.1%)
CIN	
Yes	8(6.8%)
No	110(93.2%)
Complications	
Heart failure	1(0.8%)
Arrhythmias	5(4.2%)
None	112(94.9%)
Mortality	1(0.8%)

Table 3: Stratification of Contrast-induced Nephropathy based on gender and age groups (n=118)

	Contrast-induced Nephropathy		P-value
	Yes	No	
Gender			
Male	6(9.7%)	56(90.3%)	0.188
Female	2(3.6%)	54(96.4%)	
Age groups			
28-40 years	1(25.0%)	3(75.0%)	0.186
41-50 years	2(8.3%)	22(91.7%)	
51-60 years	1(2.0%)	50(98.0%)	
61-70 yers	4(10.3%)	35(89.7%)	

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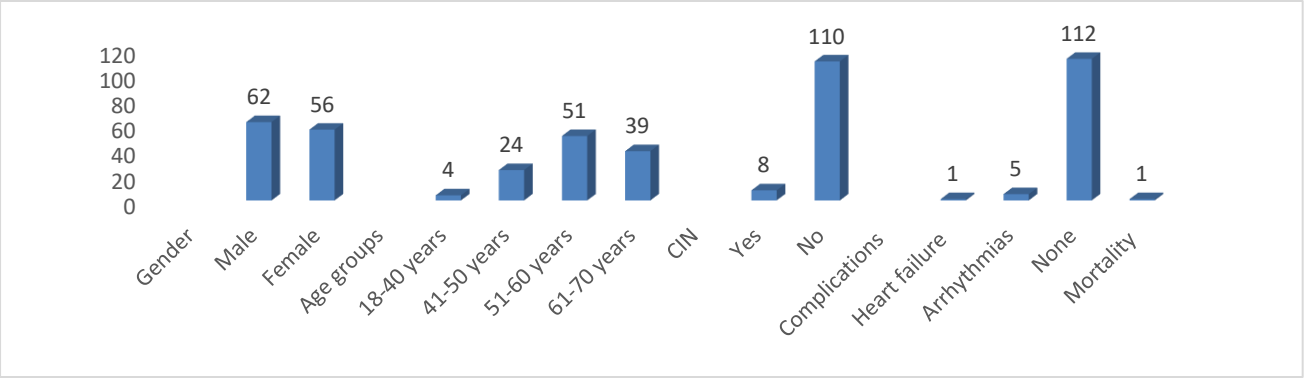

Fig 1: Characteristics of all enrolled patients

Discussion

The incidence of contrast-induced nephropathy following percutaneous coronary intervention for chronic total occlusion is a crucial area of investigation in cardiovascular medicine, as CIN can lead to significant morbidity and prolonged hospitalization. Understanding the incidence of CIN in this specific patient population can improve clinical outcomes and guide management strategies. In the present study, we have found 8 (6.8%) patients with CIN. Our study was supported by findings from Yu-Sheng Lin et al.(8), who reported an incidence of CIN at 5.4% (28 out of 516 patients). According to the literature, the incidence of CIN in coronary interventions is approximately 13%,(6) Yet few studies have specifically examined its prevalence in chronic total occlusion (CTO) interventions. Another study by Aguiar-Souto et al.(9) Examined the incidence and predictors of CIN in patients undergoing CTO PCI. They concluded that CTO intervention is associated with CIN in 6.16% of patients overall, with fewer than 7.0% of patients in moderate or high-risk categories, as determined by the Mehran scoring system, developing CIN. This finding is similar to the present study finding. The literature indicates that sufficient intravenous hydration can help lower the incidence of CIN in patients with renal impairment.(10, 11) CIN is characterized by an acute decline in renal function after exposure to contrast media, with its incidence varying based on multiple factors. Studies suggest that the incidence of CIN in the general population ranges from 1% to 6%, but this rate can be significantly higher in patients undergoing PCI, particularly in those with chronic total occlusion.(9) In high-risk groups, such as those with pre-existing renal impairment, diabetes mellitus, or heart failure, the incidence of CIN may exceed 50%.(12) Patients undergoing CTO-PCI often have a complex medical history, including advanced age and multiple comorbidities that may contribute to renal vulnerability.(13) The use of contrast media is essential for visualizing coronary anatomy during PCI; however, it poses inherent risks to renal function.(14) Therefore, identifying patients who are at a greater risk of developing CIN is essential for implementing preventive measures and optimizing patient outcomes. The technique used during CTO-PCI can also influence the incidence of CIN.(15) Factors such as the volume and type of contrast agent administered, the duration of the procedure, and the presence of complications during the intervention can affect renal outcomes.(16) Non-ionic, iso-osmolar contrast agents are often preferred due to their lower nephrotoxic potential compared to older, ionic contrast media. The consequences of CIN extend beyond the immediate clinical scenario, as patients who develop CIN may experience longer hospital stays, increased healthcare costs, and a higher risk of long-term renal impairment. This not only affects patient quality of life but also places a significant burden on healthcare systems.

Conclusion

It was concluded that the incidence of contrast-induced nephropathy following chronic total occlusion percutaneous coronary intervention presents a significant concern in clinical practice. By understanding the prevalence associated with CIN, clinicians can implement effective prevention strategies and improve patient outcomes. Continued research in this area is vital for refining risk stratification and developing targeted interventions that minimize the impact of CIN in high-risk populations.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRB-RLHP-08/23)
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

SAMI UR REHMAN (Fellow in Interventional Cardiology)
Coordination of collaborative efforts.
Study Design, Review of Literature.
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Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.
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