

## STUDY ON INCIDENCE AND RISK FACTORS OF CONTRAST INDUCED NEPHROPATHY IN PATIENTS UNDERGOING CARDIAC CATHETERIZATION STUDIES

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### Abstract

**Background:** Contrast-induced nephropathy (CIN) is a significant complication in patients undergoing cardiac catheterization studies for coronary artery disease (CAD). It is characterized by an increase in serum creatinine levels following contrast agent exposure, leading to renal dysfunction and adverse outcomes. Identifying the incidence and risk factors of CIN is crucial for optimizing patient care and outcomes in this clinical setting. This study aimed to assess the incidence of CIN and identify common risk factors associated with its development in patients undergoing cardiac catheterization studies at a tertiary care hospital. **Materials and Methods:** A retrospective analytical study was conducted at the Department of Cardiology, Coimbatore Medical College and Hospital, from October 2023 to September 2024. A total of 250 patients who underwent cardiac catheterization for CAD were included in the study cohort. Data on demographic characteristics, clinical history, medication use, and renal function were collected and analysed. Statistical analysis, including descriptive and inferential methods, was performed to assess the incidence of CIN and identify associated risk factors. **Result:** The study found that 20% of participants developed CIN following cardiac catheterization. Older age (> 61 years), male gender, smoking, and use of certain medications such as ACE Inhibitors, NSAIDs, and nephrotoxic antibiotics were identified as significant risk factors for CIN development. Notably, the use of nephrotoxic antibiotics showed a significant association with CIN. **Conclusion:** The study highlights the importance of risk assessment and preventive measures in patients undergoing cardiac catheterization to mitigate the risk of CIN.

## INTRODUCTION

Cardiac catheterization study is a widely utilized diagnostic and interventional procedure in cardiovascular medicine, providing invaluable insights into coronary anatomy, hemodynamics, and therapeutic interventions.<sup>[1]</sup> However, one of the notable complications associated with cardiac catheterization is contrast-induced nephropathy (CIN).<sup>[2]</sup> When serum creatinine (SCr) rises by more than 44.2  $\mu\text{mol/l}$  (0.5 mg/dl) or 25% above the baseline level, typically 48 hours after an iodine-based contrast exposure, it is referred to as CIN, a pathological condition.<sup>[3]</sup>

Contrast-induced nephropathy (CIN) remains a significant concern in patients undergoing cardiac catheterization studies, particularly those with pre-existing renal impairment or other risk factors. With the increasing use of contrast media in diagnostic and interventional procedures, understanding the incidence and identifying the risk factors associated with CIN becomes crucial for optimizing patient care and outcomes. While the exact pathophysiology of CIN is multifactorial and not fully elucidated, several risk factors have been identified and studied extensively.

The incidence of CIN varies widely depending on patient characteristics, procedural factors, and the type and volume of contrast media used. According

to studies, CIN accounts for around 12% of hospital acquired acute renal damage cases and is the third most common cause of the injury.<sup>4</sup> Depending on the patient's risk factors, the incidence of CIN ranges from 0% to 24%.<sup>[4]</sup> Usually, it is a temporary and curable kind of acute kidney failure. On the other hand, the development of CIN is linked to higher hospital stays, higher rates of morbidity and mortality, and higher costs.

Despite advancements in preventive measures such as hydration protocols, use of low-osmolar or iso-osmolar contrast media, and pharmacological interventions like N-acetylcysteine and sodium bicarbonate, CIN remains a challenging clinical entity with potential short-term and long-term implications on patient outcomes.

### Objectives

To assess the incidence of CIN and identify the common and important risk factors of CIN in patients undergoing cardiac catheterization studies.

## MATERIALS AND METHODS

**Study Design:** The study employed a retrospective analytical design to investigate the incidence and risk factors of contrast-induced nephropathy (CIN) in patients who underwent cardiac catheterization for Coronary Artery Disease (CAD) at the Department of Cardiology, Coimbatore Medical College and Hospital.

**Study Setting:** The study was conducted at the Department of Cardiology, Coimbatore Medical College and Hospital, spanning from October 2023 to September 2024.

**Sample Size:** A total of 250 patients were included in the study cohort, meeting the criteria of undergoing cardiac catheterization for CAD during the specified study period.

**Sampling Technique:** Purposive sampling was employed to select patients meeting the inclusion criteria and excluding those with predefined exclusion criteria.

### Study Population

#### Inclusion Criteria

Patients undergoing cardiac catheterization for Coronary Artery Disease were included in the study.

#### Exclusion Criteria

Patients who had undergone an angiographic study within the previous week and those with known renal failure were excluded from the study.

#### Data Collection

1. Demographic and clinical characteristics of patients were collected, including age, gender, comorbidities, and procedural details.
2. Left Ventricular Ejection Fraction (LVEF) was assessed as part of the clinical evaluation.
3. Baseline creatinine levels and biochemical analysis were recorded pre-procedure.
4. Repeat creatinine levels were measured daily post-procedure for three days to monitor renal function changes.

**Statistical Analysis:** Statistical analysis was performed to analyze the incidence of CIN and identify associated risk factors. Descriptive statistics, such as mean, standard deviation, and frequency distributions, were used to summarize patient characteristics. Inferential statistics, including chi-square tests and Mann Whitney U test were utilized to assess the relationship between risk factors and the development of CIN.

**Ethical Consideration:** The study protocol was approved by the Institutional Ethics Committee, ensuring adherence to ethical guidelines, patient confidentiality, and informed consent procedures.

## RESULTS

**Table 1: Profile of the study participants.**

S No	Variable	Frequency	Percentage
1	<b>Age (Years)</b>		
	< 40	34	13.6
	41 – 50	74	29.6
	51 – 60	75	30
	> 61	67	26.8
2	<b>Gender</b>		
	Male	197	78.8
	Female	53	21.1
3	<b>Smoker</b>		
	Yes	86	34.4
	No	164	65.6
4	<b>Associating factors</b>		
	Hypertension	86	34.4
	Diabetes Mellitus	93	37.2
	Anaemia	228	91.2
	Dehydration	30	12

**Table 2: Treatment history**

S No	Variable	Frequency	Percentage
1	ACE Inhibitors	82	32.8
2	Diuretics	35	14
3	NSAIDS	61	24.4

4	Nephrotoxic antibiotics	8	3.2
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20% (N=50) of the study participants had developed CIN

**Table 3: Mean Serum creatinine level during the study period**

S No	Serum Creatinine	Mean	SD	Minimum	Maximum
1	Baseline	0.792	0.169	0.3	1.2
2	POD 1	0.850	0.164	0.3	1.3
3	POD 2	0.896	0.196	0.4	1.7
4	POD 3	0.935	0.228	0.4	2.3

**Table 4: Mean difference in Serum creatinine level during the study period**

S No	Serum Creatinine	Mean	SD	P value
1	Baseline – POD 1	0.058	0.956	<0.001
2	Baseline – POD 2	0.104	0.150	<0.001
3	Baseline – POD 3	0.143	0.183	<0.001

**Table 5: Association between profile of the study participants and CIN**

Variable	CIN - Yes		CIN- No		P value
	N	%	N	%	
Age (Years)					
< 40	3	6	31	15.5	
41 – 50	23	46	51	25.5	
51 – 60	17	34	58	29	
> 61	7	14	60	30	0.006
Gender					
Male	45	90	152	76	
Female	5	10	48	24	0.030
Smoker					
Yes	27	54	59	29.5	
No	23	46	141	70.5	0.001
Associating factors					
Hypertension	16	32	70	35	0.690
Diabetes Mellitus	29	58	64	32	0.001
Anaemia	47	94	181	90.5	0.435
Dehydration	6	12	24	12	1.000

**Table 6: Association between treatment history and CIN**

Variable	CIN - Yes		CIN- No		P value
	N	%	N	%	
ACE Inhibitors	19	38	63	31.5	0.381
Diuretics	7	14	28	14	1.000
NSAIDS	10	20	51	25.5	0.418
Nephrotoxic antibiotics	5	10	3	1.5	0.002

## DISCUSSION

The present study was done with the aim to assess the incidence of CIN and identify the common and important risk factors of CIN in patients undergoing cardiac catheterization studies. It has shown that 20% (N=50) of the study participants had developed CIN. Similarly, in a study done by Marenzi et al,<sup>[5]</sup> it was shown that 19% of the study participants showed CIN. However, in a study done by Sedhai YR et al,<sup>[6]</sup> the incidence of CIN was much lower (3.2%). This disparity could be due to different exclusion criteria while recruiting the study participants.

There is a progressive increase observed from baseline to postoperative day (POD) 3, with mean levels of 0.792 at baseline, 0.850 on POD 1, 0.896 on POD 2, and 0.935 on POD 3. Significant differences are noted across all comparisons, with mean differences of 0.058 for baseline to POD 1, 0.104 for baseline to POD 2, and 0.143 for baseline to POD 3. These findings underscore the dynamic changes in renal function following the intervention,

with each day showing a statistically significant increase in serum creatinine levels compared to the baseline measurement. The present study has shown that majority of participants were between 41 to 60 years old, comprising 60.4% of the total, followed by those over 61 years (29.6%) and those under 40 years (13.6%). Participants aged > 61 years had a significantly higher percentage of CIN cases (30%) compared to younger age groups (15.5% for < 40 years, 25.5% for 41 - 50 years, and 29% for 51 - 60 years). Studies have shown that the incidence of CIN is increased with increasing age. In a study done by Ando G et al,<sup>[7]</sup> it was shown that mean age among those who had developed CIN was 73. The reasons for this age-related increase in CIN risk could be multifactorial, including age-related changes in renal function, comorbidities such as chronic kidney disease, reduced renal reserve, and altered response to contrast agents among older individuals. Understanding these age-related factors contributing to CIN incidence is crucial for implementing targeted preventive strategies and optimizing patient care, especially in older

populations undergoing procedures involving contrast agents. Gender distribution in the present study showed a higher representation of males (78.8%) compared to females (21.1%). There was a significantly higher prevalence of CIN among males. However, in a study done by Barbieri L et al,<sup>[8]</sup> it was shown that the incidence of CIN was higher among females. But this was not statistically significant in further analysis. One potential reason is the difference in sample size and participant demographics between the two studies. The present study has shown that 34.4% of the study participants were smokers. Smokers had a higher percentage of CIN cases (29.5%) compared to non-smokers (70.5%), with a significant p-value of 0.001. In a study done by Wang J et al,<sup>[9]</sup> and Rakowski T et al,<sup>[10]</sup> it was shown that 41.8% and 33.3% of those with CIN, respectively were smokers. The increased incidence of Contrast-Induced Nephropathy (CIN) among smokers can be attributed to the harmful effects of smoking on kidney blood vessels, leading to reduced renal blood flow and predisposition to ischemic injury during contrast agent administration. Smoking-related inflammation and oxidative stress further contribute to renal damage, along with the presence of common comorbidities like hypertension and diabetes that are independent risk factors for CIN. 34.4%, 37.2%, 91.2%, and 12% of the participants, respectively had hypertension, diabetes mellitus, anaemia, and dehydration. Among these factors, diabetes mellitus showed a substantial association with CIN, with diabetic participants experiencing a higher percentage of CIN cases (64%) compared to non-diabetics (35%). The p-value for this association is highly significant at 0.001. According to a research by Barbieri L et al,<sup>[8]</sup> the incidence of CIN was 10.6%, and there was a substantial correlation between the condition and glycated haemoglobin levels. Diabetes mellitus increases the formation of reactive oxygen species and alters the renal oxygen supply, making it an independent risk factor for CIN. A notable proportion of participants had been prescribed ACE Inhibitors (32.8%), NSAIDs (24.4%), and Diuretics (14%) as part of their medical regimen. However, the use of nephrotoxic antibiotics was relatively low, at 3.2%. 38%, 14% and 20% of participants who were prescribed ACE Inhibitors, Diuretics and NSAIDs developed CIN respectively. However significant association was shown among those who had nephrotoxic antibiotics. 10% of participants who received nephrotoxic antibiotics developed CIN. Nephrotoxic antibiotics are known to directly impact renal function by causing tubular injury, interstitial nephritis, or acute tubular necrosis, leading to impaired kidney function and increased susceptibility to renal complications. The relatively low proportion of participants receiving nephrotoxic antibiotics (3.2%) in this study may reflect cautious prescribing practices due to their known renal risks. However, the noteworthy 10% incidence of CIN among those who received nephrotoxic antibiotics

underscores the importance of judicious antibiotic selection, close renal monitoring, and consideration of alternative agents or dosage adjustments to minimize renal adverse effects in vulnerable patient populations.

## CONCLUSION

The findings of the study emphasize the importance of risk assessment, preventive strategies, and close monitoring of renal function in patients undergoing cardiac catheterization, especially those with predisposing risk factors. Implementing evidence-based protocols, such as hydration regimens, selecting low-osmolar contrast media, and cautious medication management, can help mitigate the risk of CIN and improve patient outcomes in this clinical setting. Further research and longitudinal follow-up are warranted to validate these findings and optimize renal care practices in cardiac catheterization patients.

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