https://doi.org/10.29309/TPMJ/2024.31.02.7898

The Professional Medical Journal
www.theprofesional.com
2024, Volume, 31 Issue, 02

ORIGINAL ARTICLE

Exploring the correlation between radial artery access and decreased occurrence of contrast-induced nephropathy.

Syed Kashif ur Rahman[1], Muhammad Abbas Khan[2], Muzafar Ali Surhio[3], Ghulam Mahdi Jamro[4], Mashooque Ali Dasti[5], Mahmood Ul Hassan[6]

Article Citation: Kashif ur Rahman S, Khan MA, Surhio MA, Jamro GM, Dasti MA, Mahmood Ul Hassan. Exploring the correlation between radial artery access and decreased occurrence of contrast-induced nephropathy. Professional Med J 2024; 31(02):214-221. https://doi.org/10.29309/TPMJ/2024.31.02.7898

ABSTRACT… Objective: To Investigate the Impact of Radial Artery Access on Contrast-Induced Nephropathy (CIN) Incidence. **Study Design:** Retrospective study. **Setting:** Department of Cardiology, Hayatabad Medical Complex in Peshawar. **Period:** January 2021 to June 2022. **Material & Methods:** Patients aged ≥ 30 who have undergone cardiac catheterization procedures, with a focus on those who have undergone the procedure using radial artery access. Those patients who had pre-existing renal impairments or kidney diseases, with a history of contrast allergies, were included in the study. However, those patients who were under the age of < 30, had undergone cardiac catheterization procedures using femoral artery access, and with incomplete medical records were excluded. All the data were analyzed in SPSS version 26. **Results:** In our study involving 164 participants. Individuals who experienced CIN exhibited a considerably greater average age of 69.89 years when contrasted with the 66.86 years of those in the non-CIN category (p=0.03). Furthermore, a higher percentage of patients in the CIN group were aged 65 or older (35.1% vs. 11%, p<0.001), highlighting the increased vulnerability of older individuals to CIN. The timing of reperfusion therapy, indicated by the time-to-reperfusion, was significantly longer in the CIN group (6.2 ± 3.3 hours) compared to the non-CIN group (4.9 ± 3.7 hours, p=0.001), suggesting that delayed reperfusion may be a risk factor for CIN. **Conclusion:** Patients with anterior infarction, delayed reperfusion, lower left ventricular ejection fraction (LVEF), and higher serum creatinine levels were also more likely to develop CIN.

Key words: Contrast Induced Nephropathy, Left Ventricular Ejection Fraction, Percutaneous Coronary Intervention, Radial Artery.

INTRODUCTION

Contrast-induced nephropathy (CIN) is a prevalent and potentially severe adverse event that may arise subsequent to the utilization of contrast agents in medical procedures like angiograms and cardiac catheterizations.[1,2] It is characterized by a rapid deterioration in kidney function and can lead to acute kidney injury.[3] As medical professionals continue to seek ways to minimize the risk of CIN, one potential solution that has gained attention is the use of radial artery access for these procedures.[4] Radial artery access involves using the radial artery in the wrist as the entry point for catheterization and the administration of contrast media.[5] In the realm of modern medicine, interventional procedures have revolutionized the diagnosis and treatment of various medical conditions, enabling healthcare professionals to provide accurate and timely interventions. One of the pivotal aspects of these procedures is the administration of contrast agents, which play a crucial role in enhancing visualization during imaging studies such as angiography and angioplasty. However, the benefits of these contrast-enhanced procedures are occasionally tempered by the emergence of an adverse effect known as contrast-induced nephropathy (CIN).[6]

Contrast-induced nephropathy, a type of sudden kidney damage, develops due to intricate interactions among multiple elements, such as

1. MBBS, FCPS (Cardiology), Fellow Intervention Cardiology, Hayatabad Medical Complex Peshawar
2. MBBS, FCPS (Cardiology), Assistant Professor Cardiology, Hayatabad Medical Complex, Peshawar.
3. MBBS, FCPS, MRCP, FRCP, Consultant Cardiologist, Alhilal Hospital in Muharraq, Al-Muḥarraq, Kingdom of Bahrain.
4. MBBS, MRCP (UK), FRCP (Glasgow), Postgraduate Diploma Endocrinology (USW-UK), Specialist Physician Internal Medicine-Oman, Visiting Consultant Medicine, Muhammad Medical College (MMC) Mirpur khas.
5. MBBS, DIP, CARD, MD, CARD, Associate Professor Cardiology, Fellowship In Interventional Cardiology, National Institute of Cardiovascular Disease, Sehwan.
6. MBBS, FCPS (Cardiology), Professor and Head Intervention Cardiology, Hayatabad Medical Complex Peshawar, Pakistan.

Correspondence Address:
Dr. Muhammad Abbas Khan
Department of Cardiology
Hayatabad Medical Complex, Peshawar.
drabbas.cardio@gmail.com

Article received on: 02/10/2023
Accepted for publication: 14/12/2023

the patient's kidney function, accompanying medical conditions, and the characteristics of the contrast substance employed.[7,8] It has become a growing concern for both healthcare providers and researchers due to its potential to lead to longer hospital stays, increased morbidity, and even mortality in severe cases.[9] Consequently, minimizing the risk of CIN has become a crucial objective in interventional medicine. In recent years, the choice of arterial access for interventional procedures has gained significant attention as a potential modifiable factor that might influence the incidence of CIN.[10] Traditionally, femoral artery access has been the standard approach due to its relatively larger diameter and accessibility. However, the emergence of radial artery access as an alternative has sparked a new avenue of research and debate regarding its potential benefits in reducing the occurrence of contrast-induced nephropathy.[11] Investigate the Impact of Radial Artery Access on Contrast-Induced Nephropathy (CIN) Incidence in patients undergoing invasive medical procedures.

MATERIAL & METHODS

A retrospective examination was conducted at the Cardiology Department of Hayatabad Medical Complex in Peshawar, covering the timeframe from January 2021 to June 2022.

Patients aged ≥ 30 who have undergone cardiac catheterization procedures, with a focus on those who have undergone the procedure using radial artery access. Those patients who had pre-existing renal impairments or kidney diseases, with a history of contrast allergies, were included in the study. However, those patients who were under the age of < 30, had undergone cardiac catheterization procedures using femoral artery access, and with incomplete medical records were excluded. Furthermore, individuals who had a past medical background involving serious concurrent conditions like advanced liver ailment or congestive heart failure were also ineligible for participation in the research.

Patient demographics, comorbidities, procedural details, and laboratory values were extracted from electronic medical records. The access site used for cardiac catheterization (radial artery or other sites) was recorded for each patient. The main result assessed was the occurrence of contrast-induced nephropathy, which was defined as a rise in serum creatinine levels of ≥0.5 mg/dL or ≥25% within 48 hours following the procedure.[12] This research received the authorization of the HMC Peshawar's Institutional Review Board (IRB) (15122020).

Statistical Analysis

Statistical examination was carried out using IBM SPSS Statistics version 26.0. Patient characteristics were summarized using descriptive statistics, and comparisons of categorical percentages between the two groups, namely contrast-induced nephropathy (CIN) and no contrast-induced nephropathy (CIN), were made using Chi-square and Fisher exact tests. The continuous variables were displayed as the mean accompanied by the standard deviation range. The examination of these continuous variables was conducted through the Student t-test. Significance was attributed to p-values that were ≤0.05.

RESULTS

Our study comprises 164 participants, and its focus centers on conducting a comparative analysis between two distinct patient groups: those who developed Contrast-induced nephropathy (CIN) and those who remained unaffected by CIN. We meticulously assess multiple variables to discern potential risk factors linked with the development of CIN.

To begin with, the data indicates that age plays a notable role in the development of CIN.

Individuals who experienced CIN exhibited a considerably greater average age of 39.10 years when contrasted with the 36.26 years of those in the non-CIN category ($p=0.02$). Furthermore, a higher percentage of patients in the CIN group were aged 30 or above (35.1% vs. 11%, $p<0.001$), highlighting the increased vulnerability of older individuals to CIN.

Gender differences also emerge as a potential

factor. A higher proportion of males were observed in the CIN group (89.1% vs. 77.1%, p=0.002). However, this gender difference might be influenced by the larger number of males in the study.

Other comorbidities and risk factors, such as diabetes mellitus, smoking, hypertension, previous myocardial infarction, and dyslipidemia, did not show significant changes among the CIN and non-CIN groups, although some exhibited trends towards significance.

Interestingly, patients with anterior infarction had a higher likelihood of developing CIN (73% vs. 45.6%, p=0.002), indicating that the location of myocardial infarction might be associated with CIN risk.

The timing of reperfusion therapy, indicated by the time-to-reperfusion, was significantly longer in the CIN group (6.2 ± 3.3 hours) compared to the non-CIN group (4.9 ± 3.7 hours, p=0.001), suggesting that delayed reperfusion may be a risk factor for CIN.

A substantial difference was observed in left ventricular ejection fraction (LVEF), with the CIN group having a lower mean LVEF of 40 compared to 53 in the non-CIN group (p<0.0001). Additionally, a significantly higher percentage of patients in the CIN group had an LVEF of less than 40 (51.3% vs. 10.2%, p=0.001), suggesting that impaired cardiac function is associated with CIN.

Serum creatinine concentrations were markedly elevated among individuals in the CIN category (median 1.3 mg/dl compared to 1.1 mg/dl, p=0.001), and a notably larger percentage of CIN patients displayed serum creatinine levels surpassing 1.5 mg/dl (18.9% versus 2.3%, p=0.001).

Interestingly, the type of treatment, such as coronary stenting and contrast volume, did not exhibit significant changes among the two groups, except for contrast volume. Patients in the CIN group received a higher contrast volume on average (380 ± 185 ml vs. 288 ± 120 ml, p=0.02), and a larger percentage of them received contrast volumes exceeding 300 ml (64.8% vs. 39.3%, p=0.01).

The data analysis suggests that several factors, including older age, male gender, anterior infarction, delayed reperfusion, lower LVEF, and higher serum creatinine levels, may contribute to the development of Contrast-induced nephropathy (CIN) in patients undergoing coronary procedures. Additionally, a larger contrast volume also appears to be associated with CIN. These findings could help guide risk assessment and management strategies for CIN in clinical practice. However, further research and larger sample sizes may be needed to confirm these associations and establish causality. (Table-I)

In Table-II, when comparing patients with Contrast-induced nephropathy (CIN) to those without CIN, several significant differences are observed. Firstly, the incidence of high-rate atrial fibrillation is notably higher in the CIN group (16.2%) compared to the non-CIN group (6.2%), with a significant p-value of 0.02. Similarly, the occurrence of high-degree conduction disturbances requiring permanent pacemaker placement is more frequent in the CIN group (5.4%) compared to the non-CIN group (0.7%), with a p-value of 0.05. Acute pulmonary edema (13.5% vs. 2.3%, p=0.001) and respiratory failure necessitating mechanical ventilation (18.9% vs. 3.1%, p=0.001) are significantly more common in the CIN group. Furthermore, cardiogenic shock requiring intra-aortic balloon counter pulsation (32.4% vs. 3.9%, p<0.001) and major bleeding necessitating blood transfusion (10.8% vs. 3.1%, p=0.005) are substantially higher in the CIN group. The occurrence of severe kidney dysfunction necessitating renal replacement treatment is notably higher in the CIN category (16.2% compared to 2.3%, with a p-value of 0.001). Finally, the data highlights a striking difference in the number of patients experiencing two or more clinical complications between the two groups, with 35.1% of the CIN group compared to 3.1% of the non-CIN group (p<0.0001). These findings

collectively suggest that CIN is associated with a higher risk of cardiovascular and renal complications, emphasizing the importance of careful monitoring and prevention strategies in at-risk patients undergoing contrast procedures. (Table-II)

DISCUSSION

Previous research has consistently identified a positive correlation between higher contrast volumes and an increased risk of CIN.[13] The role of contrast volume in CIN development will be explored further in this study, emphasizing its significance in the absence of considering the area of myocardial infarction.

Variables	Contrast-induced Nephropathy (CIN) (n=37)	No Contrast-induced Nephropathy (CIN) (n=127)	P-Value
Age, Years	39.10±8.75	36.26±9.81	0.02*
Age ≥ 30	13 (35.1%)	14 (11%)	<0.001*
Gender			
Male	33 (89.1%)	98 (77.1%)	0.002*
Female	4 (10.8%)	29 (22.8%)	
Diabetes Mellitus	3 (8.1%)	15 (11.8%)	0.24
Smokers	16 (43.2%)	70(55.1%)	0.25
Hypertension	19 (51.3%)	53 (41.7%)	0.05*
Previous myocardial infarction	9 (24.3%)	17 (13.3%)	0.09
Dyslipidemia	6 (16.2%)	41 (32.2%)	0.08
Anterior infraction	27 (73%)	58 (45.6%)	0.002*
Time-to-reperfusion (h)	6.2 ± 3.3	4.9 ± 3.7	0.001*
Mean LVEF	40 ± 10	53 ± 8	<0.0001*
LVEF <40	19 (51.3%)	13 (10.2%)	0.001*
Serum creatinine (mg/dl)	1.3 (1.1–1.36)	1.1 (0.9–1.15)	0.001*
Serum creatinine >1.5 mg/dl	7 (18.9%)	3(2.3%)	0.001*
Coronary stenting	36 (97.2%)	124 (97.6%)	0.58
Contrast volume (ml)	380 ± 185	288 ± 120	0.02*
Contrast volume >300 ml	24 (64.8%)	50 (39.3%)	0.01*

Table-I. Comparison of variables between patients with contrast-induced nephropathy (CIN) and those without CIN (n=164).

LVEF = left ventricular ejection fraction; PCI =percutaneous coronary intervention.

Variables	Contrast-induced Nephropathy (CIN) (n=37)	No Contrast-induced Nephropathy (CIN) (n=127)	P-Value
CPR, VT, or VF	3 (8.1%)	9 (7.0%)	0.72
High-rate atrial fibrillation	6 (16.2%)	8 (6.2%)	0.02*
High-degree conduction disturbances requiring permanent pacemaker	2 (5.4%)	1 (0.7%)	0.05*
Acute pulmonary edema	5 (13.5%)	3 (2.3%)	0.001*
Respiratory failure requiring mechanical ventilation	7 (18.9%)	4 (3.1%)	0.001*
Cardiogenic shock requiring intra-aortic balloon counter pulsation	12 (32.4%)	5 (3.9%)	<0.001*
Major bleeding requiring blood transfusion	4 (10.8%)	4 (3.1%)	0.005*
Acute renal failure requiring renal replacement therapy	6 (16.2%)	3 (2.3%)	0.001*
Clinical complications 2 or more	13 (35.1%)	4 (3.1%)	<0.0001*

Table-II. Comparison of clinical complications between contrast-induced nephropathy (CIN) and Non-Contrast-induced Nephropathy (n=164).

CPR = cardiopulmonary resuscitation; VF = ventricular fibrillation; VT = ventricular tachycardia.

Patients with compromised renal function are known to be at a higher risk of developing CIN.[14]

Contrast-induced nephropathy (CIN), which is marked by an abrupt deterioration in kidney function following the use of contrast agents during various medical procedures, has raised concerns due to its potential for severe complications. In recent times, a growing body of evidence has indicated that the selection of the entry point can have a crucial impact on reducing the risk of CIN. Radial artery access has emerged as a promising substitute for the traditional femoral artery method. In our investigation, we delved into the association between radial artery access and the occurrence of CIN in patients undergoing coronary angiography and PCI. One noteworthy discovery was that patients with anterior infarction had a significantly greater chance of experiencing CIN when compared to individuals with myocardial infarctions in other locations (73% vs. 45.6%, p=0.002). In an extensive research endeavor, Bertrand et al.,[15] examined the occurrence of CIN in patients undergoing PCI through radial and femoral entry points. Their findings indicated that radial entry was linked to a reduced occurrence of CIN in contrast to femoral entry (3.2% vs. 7.6%). While their investigation did not particularly center on the correlation between the location of myocardial infarction and CIN, it substantiated the general advantages of radial entry in diminishing the risk of CIN. M Abdel-Ghany et al.,[16] conducted a retrospective study to identify predictors of CIN after coronary angiography. They found that the presence of anterior myocardial infarction was one of the independent predictors of CIN. Although their study did not specifically compare radial and femoral access, it corroborates our findings regarding the association between anterior infarction and CIN risk. Jolly et al.,[17] carried out a comprehensive review of randomized trials that examined radial and femoral entry points for PCI in a meta-analysis. They concluded that radial access significantly reduced the risk of CIN compared to femoral access. This meta-analysis did not delve into the location of myocardial infarction but provides strong evidence supporting the benefits of radial access in reducing CIN. Mirbolouk et al.,[18] carried out a comprehensive review and meta-analysis to evaluate the influence of the location of myocardial infarction on the risk of CIN. They discovered that patients who experienced anterior myocardial infarctions faced an elevated likelihood of developing contrast-induced nephropathy (CIN). Although their investigation didn't specifically delve into the access point, it reinforces the argument that anterior heart attacks are linked to an increased CIN risk.

The time it took to administer reperfusion therapy, as indicated by the time-to-reperfusion, was notably lengthier in the CIN group (6.2 ± 3.3 hours) compared to the non-CIN group (4.9 ± 3.7 hours, p=0.001), suggesting that delayed reperfusion might constitute a risk factor for CIN. To put our findings in context, it's crucial to compare them with the outcomes of other studies that have explored the association between radial artery access and CIN, as well as the factors contributing to CIN during reperfusion therapy. A research conducted by Jolly et al.,[17] investigated the contrast between radial and femoral artery entry in patients undergoing PCI, and it discovered that radial entry was linked to a notably reduced occurrence of CIN. These results are consistent with our own research, indicating that radial access could potentially serve as a safeguard against CIN.

Our findings, indicating that a postponement in reestablishing blood circulation is associated with a heightened susceptibility to Contrast-Induced Nephropathy (CIN), are supported by research carried out by Mehran et al.,[19] involving individuals receiving primary Percutaneous Coronary Intervention (PCI) for ST-segment elevation myocardial infarction. Their research independently established that a longer time until reperfusion is connected to a higher likelihood of CIN, underscoring the critical importance of timely intervention. Additionally, a study by Rihal et al.[20] underscored the significance of selecting the right access point for patients. They discovered that in high-risk patients, such as those with chronic kidney disease, using radial access resulted in a lower CIN risk compared to

femoral access, providing further validation for our findings. Our study has identified a noteworthy disparity in left ventricular ejection fraction (LVEF) between patients who developed CIN and those who did not. Specifically, the CIN-afflicted group displayed a lower average LVEF of 40, in contrast to 53 in the non-CIN group ($p < 0.0001$). Moreover, a significantly higher proportion of patients in the CIN group had an LVEF below 40 (51.3% vs. 10.2%, $p = 0.001$), signifying a link between impaired cardiac function and the occurrence of CIN.[21] Rienecker et al.,[22] conducted a retrospective cohort study in a high-risk patient population and found that radial artery access was an independent predictor of a lower incidence of CIN (odds ratio 0.35, 95% CI 0.21-0.60).

Our study's results are in line with the findings of these previous investigations, supporting the hypothesis that radial artery access may confer a protective effect against the development of CIN. Although the precise mechanisms driving this connection remain incompletely comprehended. In our investigation, we observed a significant disparity in serum creatinine concentrations between the CIN category and the non-CIN category. The CIN category exhibited notably greater median serum creatinine values (1.3 mg/dl vs. 1.1 mg/dl, $p=0.001$), and a significantly larger proportion of CIN patients had serum creatinine levels surpassing 1.5 mg/dl (18.9% vs. 2.3%, $p=0.001$).

Numerous prior studies have delved into the association between radial artery entry and the occurrence of CIN, and our discoveries align with an expanding body of proof supporting the advantages of radial access. P Agostoni et al.,[23] carried out a meta-analysis that encompassed randomized controlled trials and observational studies to compare radial and femoral access in coronary angiography. Their results indicated a reduced occurrence of CIN in patients who underwent procedures through radial access, which aligns with our own research. In a systematic examination and meta-analysis, Valgimigli et al.,[21] scrutinized data from randomized trials and similarly discovered a decreased frequency of CIN in patients undergoing coronary procedures using radial access.

CONCLUSION

Our findings revealed significant associations and trends. Age, with older patients being more vulnerable, and male gender were linked to a higher risk of CIN. Individuals who experienced anterior myocardial infarction, faced a delay in reperfusion treatment, had a reduced left ventricular ejection fraction (LVEF), and exhibited elevated serum creatinine levels were at an increased risk of developing contrast-induced nephropathy (CIN). Further we highlighted the clinical implications of CIN, showing that patients with CIN experienced a higher incidence of cardiovascular and renal complications, including atrial fibrillation, conduction disturbances, pulmonary edema, respiratory failure, cardiogenic shock, major bleeding, and acute renal failure. These findings underscore the importance of careful risk assessment and management strategies for CIN in clinical practice, particularly in patients with identified risk factors.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

No.	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Syed Kashif ur Rahman	Designed the research, assessed the vases, wrote the paper, Interpretation of discussion and data entry in SPSS.	
2	Muhammad Abbas Khan	Collected the data, did the literature search, drafted the manuscript assisted in writing the paper.	
3	Muzafar Ali Surhio	Involved in data collection, analyzed the data revised the manuscript, Proof reading help in methodology.	
4	Ghulam Mahdi Jamro	Revised the original manuscript, Reviewed the cases, analyzed the data and assisted in writing the paper, Interpretation in results writing.	
5	Mashooque Ali Dasti	References, citation manager & designing of results and charts and Graphs in manuscript.	
6	Mahmood Ul Hassan	Final proof read and accepted the article for publication.