Original Article

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Association of Contrast-Induced Nephropathy with Adverse In-Hospital Outcomes in Patients Undergoing Primary Angioplasty for Acute Myocardial Infarction

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Author`s Contribution

[1,2]Substantial contributions to the conception or design of the work; or the acquisition, [4]Active participation in active methodology, [2,3]analysis, or interpretation of data for the work, [5,6]Drafting the work or revising it critically for important intellectual content

Funding Source: None
Conflict of Interest: None

Received: July 29, 2024
Accepted: Dec 27, 2024

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ABSTRACT

Objective: To assess the association of contrast-induced nephropathy (CIN) and adverse in-hospital outcomes in patients undergoing primary angioplasty for acute myocardial infarction (AMI).

Methodology: A prospective cohort study was done in National Institute of Cardiovascular Disease (NICVD), Karachi from January 2019 to January 2020. After taking informed written consent clinical examination was done and blood investigations were done at the time of admission and repeated on 3rd day for in hospital outcome i-e atrial fibrillation, cardiogenic shock, and acute pulmonary edema and CIN.

Results: Total of 249 patients with AMI undergoing PPCI were included. Out of all 99(39.7%) were females and 150(60.3%) were males with mean age of 54.82+7.888 years. The in-Hospital outcome atrial fibrillation, cardiogenic shock & acute pulmonary edema in exposed group were seen in 27(10.8%), 37(14.9%) & 29(11.6%) respectively, while in non-exposed group these were noted in 8 (3.2%), 9(3.6%) & 10 (4%) respectively.

Conclusion: The patients who developed CIN after primary angioplasty for AMI observed with higher adverse in-hospital outcomes in contrast to those who did not developed renal impairment, indicating that the occurrence of CIN worsens the clinical progression during hospitalization and rises the complications risk.

Key words: AMI, contrast media, CIN, PPCI, Complications

Cite this article as: Munir N, Hussain M, Memon SH, Talpur MFH, Ahmed B, Latif A. Association of Contrast-Induced Nephropathy with Adverse In-Hospital Outcomes in Patients Undergoing Primary Angioplasty for Acute Myocardial Infarction. Ann Pak Inst Med Sci. 2024; 20(SUPPL-2):909-914. 10.48036/apims.v20iSUPPL-2.976.

Introduction

Acute myocardial infarction (AMI) continues to be a significant contributor to high rates of global mortality besides morbidity among patients diagnosed with ST-segment elevation myocardial infarction (STEMI). STEMI is a severe form of AMI and according to recent studies it accounts for more than 60% of cases, where gender distribution shows a significantly higher proportion of more than 80% male patients.[1,2] STEMI-associated mortality rates have been reported as high as 24.5% in low-and-middle income nations.[3]

Reperfusion has been considered a cornerstone of ST-segment elevation MI management, wherein, Primary Percutaneous Coronary Intervention (PPCI) or angioplasty remains a preferred reperfusion method to improve survival, with restored coronary blood circulation and minimized infarct size.[4,5] Advancement in emergency care and widespread practice of PCI have produced significant reduction in in-hospital mortality of around 2-5%.[6-8] Despite widespread application of PCI, Contrast-induced nephropathy remains a major complication of PCI, which leads to severe deterioration of renal function within 48–72 hours of procedure due to iodinated contrast media exposure. The deterioration in renal function, referred to as acute kidney injury, is characterized by increase serum creatinine levels above 25% or more (or ≥0.5 mg/dL).[9] AMI patients often present with hypoperfusion, diabetes mellitus, or chronic kidney disease, which are associated with increased risk of renal injury. CIN has been reported

to account for 10–20% of STEMI patients undergoing primary PCI, wherein older age, reduced glomerular filtration, increased contrast volume, and cardiogenic shock were found to be contributing factors.[10] CIN development among STEMI patients after primary PCI (pPCI) has been associated with adverse in-hospital outcomes, including prolonged hospitalization, higher major adverse cardiac events (MACE), and increased in-hospital mortality than those without CIN.[11,12] A recent study reported in-hospital mortality of 10% among AMI patients who developed CIN following pPCI, where arrhythmias, infarct patterns, and cardiac failure were identified as associated unfavorable factors.[12] Overall as the CIN is a common and serious complication following primary angioplasty among patients with AMI due to hemodynamic instability, comorbid conditions, and emergency contrast media usage. The reported evidence regarding associated worse in-hospital outcomes require an additional of renal risk assessment in AMI management to improve outcomes among the patients undergoing primary angioplasty and the local data on this association is very limited. Hence present is therefore supportable to assess the relationship between CIN and adverse in-hospital outcomes among individuals undergoing primary angioplasty, with goal to improving risk stratification, strategies for prevention, and overall outcomes of the patients.

Methodology

This was a prospective cohort study, carried out in National Institute of Cardiovascular Disease, Karachi. Study was done during one year from January 2019 to January 2020. A sample of 249 patients was calculated by using open EPI sample size calculator version, considering atrial fibrillation of 15% vs. 4% in patients with and without (CIN) and expected prevalence of CIN 19%[15], with 80% power of test, 95% confidence level, which was further divided as (48 exposed group + 201 unexposed group). Non –probability consecutive sampling technique was used. Patients aged 40 to 70 years, both gender and patients diagnosed with acute myocardial infarction undergoing primary angioplasty were included. Patients with renal impairment before PCI, prior history of any cardiac related surgery, prinzmetal angina (previous history of cardiac chest pain less than 20 mints at rest that occurs in cycles), patients with previous history of valvular heart disease, patients with deranged coagulation profile and patients with left bundle branch block as per record of patient were excluded. After taking demographic information, a verbal informed consent was taken from all the patients or their attendant admitted with AMI undergoing PCI. All those who fulfill the inclusion criterion were followed for 03 days for in-hospital outcomes and CIN as per operational definition during hospital stay. Patients were categorized in two groups either exposed or non-exposed group according to CIN (impairment of renal function measured as either a 25% increase in serum creatinine from baseline or a 0.5 mg/dL (44 µmol/L) increase in absolute serum creatinine value within 48-72 hours after PCI. A 12 leads ECG of all patients were done to observe AMI changes by researcher and counter checked by the consultant cardiologist having experienced of more than 2 years. In all patients PCI was performed by consultant cardiologist with at least five years of experience. A baseline echocardiography was also performed to identify any valvular or structural heart disease. History of risk factors for AMI like history of hypertension, diabetes mellitus, smoking, obesity and hyperlipidemia was also noted. A 10ml of blood sample was taken for the routine blood investigations form each patient at the time of admission and repeated on 3rd day for in hospital outcomes and CIN. CIN, Atrial fibrillation, Cardiogenic shock, and Acute pulmonary edema was recorded and all the collected data was noted on Performa by researcher. Confounding variables were controlled by strictly following inclusion and exclusion criteria and stratification. Patient information was kept secured and available to authorized person only. All the collected data was entered and analyze using SPSS version 20.

Results

A total 249 patients diagnosed with acute myocardial infarction undergoing primary angioplasty were selected to conduct this study, where exposed included 48 subjects of which 22(8.8%) were female while 26(10.4%) were male, with mean age of 54.825$\pm$8.101 years, while non-exposed included 201 patients of which 77(30.9%) were female while 124(49.8%) were male, with mean age 54.812$\pm$7.003 years. The overall mean age came out to be 54.82$\pm$7.88 years. The mean BMI in exposed group was 27.020$\pm$3.958 kg/m^2 while in non- exposed group it was 27.218$\pm$3.415 kg/m^2 with overall mean BMI of 27.180$\pm$3.519 kg/m^2. The residential status in exposed group was rural in 23(9.3%) patients and urban in 25(10%), while in non-exposed group it was rural in 87(34.9%) and urban in 114(45.8%), In exposed group 12(4.8%) patients were smokers while in non-exposed group 39(15.7%) patients were smokers. In exposed group hypertension was noted in 34(13.7%) patients while in non-exposed group it was noted in 144(57.8%) patients. In

exposed group diabetes mellitus was noted in 20(8%) patients while in non-exposed group it was noted in 77(30.9%) patients. In exposed group dyslipidemia was noted in 34(13.7%) patients while in non-exposed group it was noted in 139(55.8%) patients. Table I.

Table I: Analysis of demographic and clinical characteristics with respect to groups (N=249)

Variables	Groups		Overall	P-value
	Exposed-G N=48	Non exposed-G N=201		
Mean age	54.825±8.101	53.812±7.00	54.82±7.88	0.852
Mean BMI	27.020±3.95	28.218±3.41	27.180±3.51	0.728
Gender				
Female	22(8.8%)	77(30.9%)	99(39.7%)	0.001
Male	26(10.4%)	124(49.8%)	150(60.3%)	
Residential status groups				
Rural	23(9.3%)	87(34.9%)	110(42.2%)	0.045
Urban	25(10%)	114(45.8%)	139(55.8%)	
Smoking groups				
No	36(14.5%)	162(65.0%)	198(79.5%)	0.027
Yes	12(4.8%)	39(15.7%)	51(20.5%)	
Hypertension				
No	14(5.6%)	57(22.9%)	71(28.5%)	0.001
Yes	34(13.7%)	144(57.8%)	178(71.5%)	
Diabetes Mellitus groups				
No	28(11.3%)	124(49.8%)	152(61.1%)	0.001
Yes	20(8%)	77(30.9%)	97(38.9%)	
Dyslipidemia				
No	14(5.6%)	62(24.9%)	76(30.5%)	0.001
Yes	34(13.7%)	139(55.8%)	173(69.5%)	
Obesity groups				
No	35(14.1%)	144(57.8%)	179(71.9%)	0.001
Yes	13(5.2%)	57(22.9%)	70(28.1%)	

The in-hospital outcome atrial fibrillation, cardiogenic shock & acute pulmonary edema in exposed group were seen in 27(10.8%) patients, 37(14.9%) & 29(11.6%) respectively, while in non-exposed group atrial fibrillation, cardiogenic shock & acute pulmonary edema were noted in 8 (3.2%), 9(3.6%) & 10 (4%) respectively, as shown in Table II.

Overall, diabetes mellitus, hypertension, dyslipidemia, obesity, and smoking status showed a statistically significant association with atrial fibrillation, cardiogenic shock, and acute pulmonary edema (p = 0.001). Among these, diabetes mellitus and hypertension demonstrated the highest relative risks across all outcomes, indicating a strong contribution to acute cardiac complications. Smoking was also markedly associated, particularly with cardiogenic shock and acute pulmonary edema (RR up to 15.55). In contrast, age groups exhibited increased relative risks; however, these associations were not statistically significant (p > 0.05). Gender showed a significant association with all three outcomes, with comparable risk estimates observed among males and females. Table III.

Discussion

In this study, a total 249 patients diagnosed with acute myocardial infarction undergoing primary angioplasty were included, where exposed included 48 subjects of which 22(8.8%) were female while 26(10.4%) were male, with mean age of 54.825±8.101 years, while non-exposed included 201 patients of which 77(30.9%) were female while 124(49.8%) were male, with mean age 54.812±7.003 years. The overall mean age came out to be 54.82±7.88 years. Comparable demographic details were documented in the study of Marenzi et al[13] who reported that with mean age of 62 years and majority of males (79.3%), CIN developed in 19% of patients out of overall 208 AMI subjects. Similarly, in the study of Santos et al.,[14] mean age was 66.6 years, with standard deviation of ± 11.7 years, and relatively higher incidence of CIN noted among 23.8% of patients. Another study conducted by Batra et al.[15] also reported similar statistics.

In our study cohort, the mean BMI in exposed group was 27.020±3.958 kg/m^2 while in non- exposed group it was 27.218±3.415 kg/m^2 with overall mean BMI of 27.180±3.519 kg/m^2. Aligning with our findings, in a study carried out by Talreja et al[16] mean BMI of the study

Table II: In-hospital outcome distribution with respect to groups.

Atrial Fibrillation groups	Exposed group	Non-exposed group	Overall	P-values	Relative Risk
No	21(8.5%)	193(77.5%)	214(86%)	0.003	14.41
Yes	27(10.8%)	8(3.2%)	35(14%)		
Total	48(19.3%)	201(80.7%)	249(100%)		
Cardiogenic shock groups					
No	11(4.4%)	192(77.1%)	203(81.5%)	0.005	17.5
Yes	37(14.9%)	9(3.6%)	46(18.5%)		
Total	48(19.3%)	201(80.7%)	249(100%)		
Acute pulmonary Edema groups					
No	19(7.7%)	191(76.7%)	210(84.4%)	0.003	12.32
Yes	29(11.6%)	10(4%)	39(15.6%)		
Total	48(19.3%)	201(80.7%)	249(100%)		

Table III: Relative Risk of Atrial Fibrillation, Cardiogenic Shock, and Acute Pulmonary Edema According to Risk Factors (n= 249)

Risk Factor	Category	Atrial Fibrillation RR	Cardiogenic Shock RR	Acute Pulmonary Edema RR	P-value
Age (years)	39–54	22.71	19.75	17.30	>0.05
	55–70	9.61	15.20	8.92	>0.05
Gender	Female	13.21	17.30	12.50	>0.05
	Male	14.25	16.92	11.36	>0.05
Diabetes Mellitus	Absent	12.64	14.66	10.03	0.001
	Present	**20.00**	**28.00**	**22.00**	0.001
Hypertension	Absent	10.20	9.02	7.38	0.001
	Present	**18.51**	**28.29**	**17.29**	0.001
Dyslipidemia	Absent	8.92	16.35	11.15	0.001
	Present	**17.62**	**17.76**	**12.98**	0.001
Obesity	Absent	10.34	16.26	10.34	0.001
	Present	**16.79**	**18.09**	**13.08**	0.001
Smoking Status	Non-smoker	**14.83**	17.00	4.90	0.001
	Smoker	13.32	**23.32**	**15.55**	0.001

subjects was 27.3 ± 2.7 kg/m². Consistently, another study conducted by Babar et al.[17] also documented a comparable mean 26.76 ± 5.40 kg/m² in their PCI cohort. In current study, according to the residential status, in both the exposed and non-exposed groups urban patients (10% and 45.8% respectively) were more common than the rural patients (9.3% and 34.9% respectively), this higher participation of urban residents may reflect their ease of access to cardiac care facilities, while rural patients generally face delays and barriers in reaching specialized centers. Moreover, smokers were more frequent in non-exposed group (15.7%) compared to exposed group (4.8%) participants. In exposed group hypertension was noted in 34(13.7%) patients while in non- exposed group it was noted in 144(57.8%) patients. In exposed group diabetes mellitus was noted in 20(8%) patients while in non-exposed group it was noted in 77(30.9%) patients. In exposed group dyslipidemia was noted in 34(13.7%) patients while in non-exposed group it was noted in 139(55.8%) patients. In agreement, the study of Talreja et al[16] reported a considerably higher proportion of risk factors in their study cohort compared to our study subjects, wherein smokers were 49.3%, hypertensive patients were 66.0%, and diabetics were 62.7%.

Consistently, in the study of Channappagoudra et al[18] on 140 STEMI patients undergoing primary PCI, the most common risk factors were smoking in 45.7% patients, followed by hypertension in 36.4%, diabetes mellitus in 28.6%, and dyslipidemia in 22.9% of patients. Comparably, in a recent study of Masoomi et al[19] although, hypertension (71.8%) was the most common risk factors, followed by diabetes mellitus (44.6%), and Smokers (24.9%), only diabetes mellitus and Smoking were significantly associated with Contrast-induced nephropathy (CIN) development (p= 0.009 and p=0.04 respectively). The differences in risk factors can possibly be attributed to differences in sample size, inclusion/exclusion criteria, definition of risk factors, and regional lifestyle patterns.

In present study, in-hospital outcome, including cardiogenic shock, atrial fibrillation, and acute pulmonary edema in exposed group were seen in 14.9%, 10.8%, and 11.6% of patients respectively, while in non-exposed group atrial fibrillation, cardiogenic shock, and acute pulmonary edema were noted in 3.2%, 3.6%, and 4% of patients respectively. In line with these findings, in the study of Khorshid et al[20] patients in CIN group experienced significantly more *acute pulmonary edema (*15%) *and cardiogenic shock* (15% vs. 1.7%) compared to those without CIN (3.3% and 1.7% respectively); p<0.05, suggesting more adverse in-hospital events among those in CIN group. Further aligning with these, in a study conducted by Khalfallah et al[21] Cardiogenic shock was significant factor of CIN and adverse outcomes. They found that patients in CIN group experienced significantly higher incidences of heart failure (18.6%), cardiac arrest (8.5%), and cardiogenic shock (16.9%) than those without CIN, wherein heart failure was present in 7.3%, cardiac arrest in 2.8%, and cardiogenic shock was noted in 6.9% of patients (P< 0.05). Other studies conducted by Marenzi et al[13] and Antia et al[22] also reported comparable findings, suggesting that patients with CIN experience significantly higher incidence of in-hospital complications and major adverse cardiac events compared with those without CIN.

In our study, diabetes mellitus, hypertension, dyslipidemia, obesity, and smoking status showed a statistically significant association with atrial fibrillation, cardiogenic shock, and acute pulmonary edema (p =

0.001). Among these, diabetes mellitus and hypertension demonstrated the highest relative risks across all outcomes, indicating a strong contribution to acute cardiac complications. Smoking was also markedly associated, particularly with cardiogenic shock and acute pulmonary edema (RR up to 15.55). In agreement with these findings, a recent study conducted by Gatuz et al.[23] also found statistically significant association between diabetes mellitus and in-hospital major adverse cardiovascular events among patients experiencing AMI complicated by cardiogenic shock. Similarly, in the study of Masoomi et al[24] AMI patients with CIN observed significantly more adverse in-hospital outcomes (cardiogenic shock and heart failure, with P = 0.046 and P = 0.049 respectively) after primary PCI. Moreover, smoking, diabetes, and heart failure were significant risk factors of contrast-induced nephropathy (P = 0.009, P = 0.04, and P = 0.049 respectively). Consistently, Mavungu et al[25] also reported that acute heart failure was a major complication among STEMI patients. Additionally, hypertension and smoking were independent risk factors of acute heart failure, indicating association with adverse cardiac outcomes. In present study, gender showed a significant association with all three outcomes (atrial fibrillation, cardiogenic shock, and acute pulmonary edema), with comparable risk estimates observed among males and females. In contrast, age groups exhibited increased relative risks; however, these associations were not statistically significant (p > 0.05). Consistent findings were documented in the study of Sadowski et al[26] who revealed that in-hospital adverse outcomes were significantly higher among women presenting with STEMI compared to men. However, after adjustment for age and comorbidities, gender itself was not independently associated with mortality.

Conclusion

Overall observation revealed that the patients who developed CIN after primary angioplasty for AMI observed with higher adverse in-hospital outcomes in contrast to those who did not developed renal impairment. Overall findings indicated that the occurrence of CIN worsens the clinical progression during hospitalization and rises the complications risk. However, the timely detection of high-risk patients and the implementation of preventive and protecting evaluates may help decrease these complications and enhance the outcomes during hospitalization following primary angioplasty.

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