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ORIGINAL ARTICLE

Frequency of Acute Kidney Injury in Patients Presenting with Acute ST-Elevation Myocardial Infarction and Its Relationship with In-Hospital Mortality

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ABSTRACT

Objective: To determine the frequency of acute kidney injury in patients presenting with acute ST elevation myocardial infarction and to compare the frequency of in-hospital mortality between patients presenting with acute ST elevation myocardial infarction with versus without acute kidney injury at a tertiary care hospital.

Design: It was a descriptive case series.

Study Settings: Department of Cardiology, Shaikh Zayed Hospital Lahore-Pakistan over a period of 6 months from January 2021 to June 2021.

Material and Methods: A total of 128 patients of both genders aged between 18-70 years presenting with in first 12 hours of acute STEMI at emergency ward of cardiology department were included in this descriptive case series study. An informed written consent was taken from all the participants. All these patients were managed as per standard departmental protocols. Renal function was assessed within 30 minutes of presentation and then after 72 hours of admission and acute kidney injury was labelled if there was ≥0.5 mg/dl increase in serum creatinine level from baseline. These patients were followed till discharge and death of the patient during hospital stay was noted. It was then compared between patients with versus without acute kidney injury.

Results: The patients had mean age of 53.8±11.3 years. There were 86 (67.2%) males and 42 (32.8%) females with a male to female ratio of 2.1:1. 97 (75.8%) patients were obese, 65 (50.8%) patients were diabetic and 87 (68.0%) patients were hypertensive. 72 (56.3%) patients were active smokers. 25 (19.5%) patients with acute STEMI developed acute kidney injury while 10 (7.8%) patients died during hospital stay. The frequency of in-hospital mortality was significantly higher in acute STEMI patients with AKI as compared to those without AKI (24.0% vs. 3.9%; p-value=0.004). When compared similar difference was noted in in-hospital mortality between acute STEMI patients with versus without AKI across various subgroups based on age, gender, BMI, diabetes, hypertension, smoking, ASA status, thrombolysis and need for PCI.

Conclusion: A substantial proportion of patients presenting with acute ST-segment elevation myocardial infarction developed acute kidney injury that was associated with increased frequency of mortality among such patients which warrants routine monitoring of renal function among patients presenting with acute ST-segment elevation myocardial infarction and consideration of cases positive of AKI at higher risk of mortality so that risk stratification and anticipated management may improve the outcome of such patients in future practice.

Keywords: Acute ST Elevation Myocardial Infarction, Acute Kidney Injury, In-Hospital Mortality.

INTRODUCTION

Reducing morality and earlier hospital discharge are the current targets of treatment among patients presenting with acute ST-elevation myocardial infarction (STEMI). Timely identification of high risk patients allows anticipated better monitoring and care to reduce the in-hospital mortality.[1] A number of poor prognostic factors including but not limited to concomitant presence of diabetes, hypertension and smoking have been identified so far.[2,3] However many of these arc non-modifiable and hunt for modifiable poor prognostic factors among acute STEMI patients continues.[2]

Acute kidney injury (AKI) is a common complication that affects a substantial number of hospitalized patients with acute STEMI.[3] Research in the past few years have related the development of AKI with poor prognosis in such patients.[4-8] In a recent European study conducted over 245 acute STEMI patients, Sinkovic et al. observed that 34 (13.9%) patients developed acute kidney injury and that the frequency of in-hospital mortality was significantly high among such patients in comparison with those without AKI (76.5% vs. 33.6%; p-value<0.001).[4] In another similar study conducted over 760 Japanese patients with STEMI. Moriyama et al. observed the frequency of AKI to be 9.0%. They also reported similar higher frequency of in-hospital mortality among such patients (25.0% vs. 3.0%; p-value<0.001).[5] Comparable results have also been published in another study where Shacham et al. evaluated 842 Israeli patients with acute STEMI and reported AKI in 52 (6.2%) patients and significantly higher frequency of mortality among such patients as compared to patients with STEMI but without AKI (13.4% vs. 2.4%: p-value<0.001)[6]

In the light of this evidence, AKI is a frequent complication in patients presenting with acute STEMI and appears to be related with higher frequency of death during hospital stay. It can be thus advocated that renal status should be routinely monitored among such patients and should be used for their risk stratification and management planning. However, before concluding its worth mentioning that the available evidence is not conclusive and contains controversy where Safi et al. in a recent study involving 70 Bangladeshi patients with acute STEMI reported no significant difference in in-hospital mortality between patients with versus without acute kidney injury (5.7% vs. 0.0%; p-value=0.493).[7] Similar insignificant difference has also been reported by Kim et al. in a Chinese study (Unadjusted OR=0.77; p-value=0.800).[8] Considering this controversy and lack of local such published material (to the best of candidate's knowledge), need for the present study was felt.

MATERIAL AND METHODS

Sample size of 128 cases was calculated with 95% confidence level and 6% margin of error while taking expected frequency of acute kidney injury to be 13.9% among patients with acute STEMI.[4] Patients presenting with acute STEMI at emergency department of Cardiology, Shaikh Zayed Hospital Lahore-Pakistan were included in the study after written informed consent. Inclusion criteria were patients of both genders aged between 18-70 years

presenting with acute STEMI and presenting with in first 12 hours of onset of pain. While patients with recurrent STEMI, having undergone bypass surgery or percutaneous coronary intervention, and with co-morbid conditions falling under ASA class IV or above were excluded. These patients underwent estimation of serum creatinine and acute kidney injury was diagnosed. All the patients were given standard treatment as per department protocols including oxygen inhalation, analgesia and anti-coagulation along with thrombolysis and percutaneous coronary intervention as decided upon patient's profile and consultant's decision. These patients were discharged when the discharge criteria were met and death of the patient during hospital stay was noted. All the creatinine levels were acquired from a single lab (hospital's lab) and all the patients were managed in ward by a single cardiac care team including the candidate to eliminate bias. Exclusion criteria were used to control confounding variables. All the collected data was entered into and analyzed through SPSS version 21.0.

Numerical variables like age and BMI have been presented by mean ±SD. Categorical variables i.e. gender, acute kidney injury, diabetes (BSR ≥200 mg/dl), smoking (≥5 packs/week), hypertension (BP ≥140/90 mmHg), thrombolysis, need for percutaneous coronary intervention, ASA status (I/II/III) and in-hospital mortality have been given as frequency and percentage. Frequency of in-hospital mortality has been compared between acute STEMI patients with versus without acute kidney injury and chi-square test has been applied taking p-value ≤0.05 as significant. Data has been stratified for age, gender, BMI, diabetes, smoking, hypertension, ASA status, thrombolysis and need for percutaneous coronary intervention to address effect modifiers. Post-stratification, chi-square test has been applied taking p-value ≤0.05 as significant.

RESULTS

Mean age of the patients was 53.8±11.3 years within range of 32-70 years. The number of patients with age ≥45 years was 82 (64.1%). Male to female ratio was 2.1:1.

Table 1: Demographic Characteristics of Patients with Acute STEMI

Characteristics	Participants (n=128)	Characteristics	Participants (n=128)
Age (Years)	53.8±11.3	Smoking	
• <45 years	46 (35.9%)	• Yes	72 (56.3%)
• ≥45 years	82(64.1%)	• No	56 (43.7%)
Gender		Thrombolysis	
• Male	86 (67.2%)	• Yes	95 (74.2%)
• Female	42 (32.8%)	• No	33 (25.8%)
BMI (Kg/m^2)	30.7±3.1	PCI	
• Obese	97 (75.8%)	• Yes	76 (59.4%)
• Non-Obese	31 (24.2%)	• No	52 (40.6%)
Diabetes		ASA Class	
• Yes	65 (50.8%)	• Class-I	43 (33.6%)
• No	63 (49.2%)	• Class-II	43 (33.6%)
Hypertension		• Class-III	42 (32.8%)
• Yes	87 (68.0%)	-	
• No	41 (32.0%)	-	

Table 2: Frequency of AKI in Patients with Acute STEMI

Acute Kidney Injury	Frequency (n)	Percent (%)
Yes	25	19.5%
No	103	80.5%
Total	128	100.0%

Table 3: Frequency of AKI across Various Subgroups of Patients with Acute STEMI

Groups/Sub-Groups	n	AKI n (%)	p-value	Groups/Sub-Groups	n	AKI n (%)	p-value
Age				Smoking			
□□<45 years	146	9 (19.6%)	0.994	□□Yes	72	15(20.8%)	0.674
□□≥45 years	882	16(19.5%)		□□No	56	10 (17.9%)	
Gender				Thrombolysis			
□□Male	886	16(18.6%)	0.705	□□Yes	95	119(20.0%)	0.82
□□Female	442	9(21.4%)		□□No	33	6(18.2%)	
BMI				PCI			
□□Obese	997	20(20.6%)	0.583	□□Yes	76	15(19.7%)	0.943
□□Non-Obese	331	5(16.1%)		□□No	52	110(19.2%)	
Diabetes				ASA Class			
□□Yes	65	13 (20.0%)	0.892	□□Class-I	43	77(16.3%)	0.67
□□No	63	12 (19.0%)		□□Class-II	43	8(18.6%)	
Hypertension				□□Class-III	442	10 (23.8%)	
□□Yes	87	17 (19.5%)	0.997	Chi-square test, observed difference was statistically insignificant			
□□No	41	8 (19.5%)					

Table 4: Frequency of In-Hospital Mortality in Patients with Acute STEMI

In-Hospital Mortality	Frequency (n)	Percent (%)
Yes	10	7.8%
No	118	92.2%
Total	128	100.0%

Table 4: Comparison of In-Hospital Mortality in Patients with Acute STEMI with versus without Acute Kidney Injury

In-Hospital Mortality	AKI (n=25)	No-AKI (n=103)	p-value
Yes	6 (24.0%)	4 (3.9%)	0.004*
No	19 (76.0%)	99 (96.1%)	
Total	25 (100.0%)	103 (100.0%)	

Fisher's exact test, * observed difference was statistically significant

Table 6: Comparison of In-Hospital Mortality in Patients with Acute STEMI with versus without Acute Kidney Injury across study variables

Description	In-Hospital Mortality	With AKI (n=25)	Without AKI(103)	Total	p-value
BMI					
Obese	Yes	5 (25.0%)	3(3.9%)	8(8.2%)	0.009*
	No	15(75.0%	74(96.1%)	89(91.8%)	
Non Obese	Yes	1(20.0%)	1(3.8%)	2(6.5%)	0.301
	No	4(80.4%)	25(96.2%)	29(93.5%)	
Diabetes					
Yes	Yes	3 (23.1%)	2(3.8%)	5(7.7%)	0.051
	No	10(76.9%)	50(96.2%)	60(92.3%)	
No	Yes	3(25.0%)	2(3.9%)	5(7.9%)	0.044*
	No	9(75.0%)	49(96.1%)	58(92.1%)	
Hypertension					
Yes	Yes	4(23.5%)	3(4.3%)	7(8.0%)	0.025*
	No	13(76.5%)	67(95.7%)	80(92.0%)	
No	Yes	2(25.0%)	1(3.0%)	3(7.3%)	0.092
	No	6(75.0%)	32(97.0%)	38(92.7%)	
Smoker					
Yes	Yes	4(26.7%)	3(5.3%)	7(9.7%)	0.031*
	No	11(73.3%)	54(94.7%)	65(90.3%)	
No	Yes	2(20.0%)	1(2.2%)	3(5.4%)	0.079
	No	8(80.0%)	45(97.8%)	53(94.6%)	
Thrombolysis					
Yes	Yes	5(26.3%)	3(3.9%)	8(8.4%)	0.007*
	No	14(73.7%)	73(96.1%)	87(81.6%)	
No	Yes	1(16.7%)	1(3.7%)	2(6.1%)	0.035
	No	5(83.3%)	26(96.3%)	31(93.9%)	
PCI					
Yes	Yes	4(26.7%)	3(4.9%)	7(9.2%)	0.025*
	No	11(73.3%)	58(95.1%)	69(90.8%)	
No	Yes	2(20.0%)	1(2.4%)	3(5.8%)	0.091
	No	8(80.0%)	41(97.6%)	49(94.2%)	
ASA Class					
I	Yes	1(14.3%)	1(2.8%)	2(4.7%)	0.302
	No	6(85.7%)	35(97.2%)	41(95.3%)	
II	Yes	2(25.0%)	1(2.9%)	3(7.0%)	0.084
	No	6(75.0%)	34(97.1%)	40(93.0%)	
III	Yes	3(30.0%)	2(6.3%)	5(11.9%)	0.078
	No	7(70.0%)	30(93.7%)	37(88.1%)	

Fisher's exact test, * observed difference was statistically significant

Mean BMI of the patients was 30.7±3.1 Kg/m2. Majority of the patients 97 (75.8%) were obese, 65(50.8%) were diabetic, and 87

(68.0%) patients were hypertensive. 72 (56.3%) patients were active smokers. 43 (33.6%) patients were from ASA-Class I and II while 42 (32.8%) patients belonged to ASA-Class III. Thrombolysis was attempted in 95 (74.2%) patients while 76 (59.4%) patients underwent percutaneous coronary intervention as shown in Table 1. 25 (19.5%) patients with acute STEMI developed acute kidney injury as shown in Table 2.

The groups had insignificant difference when compared for frequency of acute kidney injury across various based on age (p=0.994), gender (p=0.705), BMI (p=0.583), diabetes (p=0.892), hypertension (p=0.997), smoking (p=0.674), ASA status (p=0.670), thrombolysis (p=0.820) and PCI (p=0.943) as shown in Table 3. 10 (7.8%) patients with acute STEMI died during hospital stay as shown in Table 4. The frequency of in-hospital mortality was significantly higher in acute STEMI patients with AKI as compared to those without AKI (24.0% vs. 3.9%; p-value=0.004) as shown in Table 5. When compared similar difference was noted in in-hospital mortality between acute STEMI patients with versus without AKI across various subgroups based on age, gender, BMI, diabetes, hypertension, smoking, ASA status, thrombolysis and need for PCI as shown in Table 6.

DISCUSSION

A common and dramatic sign of coronary artery disease is acute myocardial infarction with STEMI.[1] A constellation of ischemic chest pain symptoms, along with typical ST-segment elevation on the ECG and a subsequently rising level of myocardial necrosis biomarkers, are used to make the diagnosis of ST-segment elevation MI.[1,2] Over the past 20 years, mortality following STEMI has steadily declined as early intervention with percutaneous coronary angioplasty (PCI) has become more common.[1] Cardiovascular risk has been seen to rise over time as renal function declines.[3] The rapid impairment of renal function following an episode of acute myocardial ischemia, however, has been documented in a number of investigations.[3-8] AKI develops in these patients as a result of a number of causes, including parenchymal ischemia, direct and indirect tubular injury, or endothelial damage.[4] A few recent studies also suggested that this acute renal dysfunction was related with an elevated risk of death and might be utilized to risk stratify and manage such cases.[4-6] However, there was disagreement in the prior literature,[4-8] which made the present investigation necessary.

In this study, mean age of the patients presenting with acute STEMI was 53.8±11.3 years. A similar mean age of 52.93±13.30 and 52.0±10.8 years by Saleem et al. and Jafary et al., respectively among acute STEMI patients in Pakistan.[9,10] However, a higher mean age was reported by Adam et al. as 57.9±12.7 in Pakistan.[11] Singh et al. and Das et al. reported a comparable mean age of 58.0±13.6 years and 56.6±10.3 years in ACS patients in India and Bangladesh respectively.[12,13] A slight male predominance among patients of acute STEMI was observed in this study with a male to female ratio of 2.1:1. Similar male predominance was reported Lashari et al. as 2.1:1, Shaikh et al. as 2.2:1, Adam et al. as 1.9:1 and Singh et al. as 2:1.[14,15,11,12]

In the present study among 128 patients with acute STEMI, 75.8% patients were obese, 50.8% patients were diabetic and 68.0% patients were hypertensive. 56.3% patients were active smokers. Saleem et al. in Pakistan reported similar frequency of smoking (57.8%) and obesity (72.2%) among such patients.[9] Our findings are similar to results of Iqbal et al. who reported similar frequency of diabetes (54.6%) and smoking (52.5%) but lower frequency of obesity (32.5%) among STEMI patients presenting at Divisional Headquarter Hospital, Faisalabad.[16] Adam et al. in another local study, reported similar frequency of hypertension (70.4%) and diabetes (51.2%) among such cases.[11] Roe et al. reported comparable frequency of hypertension (68.6%) in USA.[17] Cordero et al. made similar observation in Spanish patients with ACS and reported the frequency of hypertension to be 68.5%.[18]

AKI was developed in 19.5% patients with acute STEMI. Our observation is in line with another similar local study where Khan et al. evaluated kidney function among 116 patients presenting with STEMI at Hayatabad Medical Complex, Peshawar and observed AKI in 19.8% patients, Aijaz et al. as 19.6%, Khan et al. as 20.7% and El-Ahmadi et al. as 19.1%.[19-22] Marbach et al. reported a comparable frequency of 21.5% in Canadian such patients and Chen et al. observed 19.9% in China while Mezhonov et al. reported it to be 20.5% in Russia.[23-25]

We observed that frequency of in-hospital mortality was significantly higher in acute STEMI patients with AKI as compared to those without AKI (24.0% vs. 3.9%; p-value=0.004). When compared similar difference was noted in in-hospital mortality between acute STEMI patients with versus without AKI across various subgroups based on age, gender, BMI, diabetes, hypertension, smoking, ASA status, thrombolysis and need for PCI. Our observation is comparable to that of Mezhonov et al. (2021) who observed a similar link between AKI and mortality in Russian patients with acute STEMI. The author reported that the frequency of in-hospital mortality was significantly higher among acute STEMI patients with AKI as compared to those without AKI (20.0% vs. 4.7%; p-value=0.001).[25] Previously Moriyama et al. conducted a similar study in Japan and reported similar significant difference in the frequency of in-hospital mortality in ACS patients with versus without AKI (25.0% vs. 3.0%; p-value<0.001).[5] Comparable results have also been published in another study where Shacham et al. evaluated Israeli patients with acute STEMI and reported significantly higher frequency of mortality with AKI (13.4% vs. 2.4%; p-value=0.001).[6] El-Ahmadi et al. conducted a similar study in Danish patients of acute STEMI and observed similar significant difference in in-hospital mortality with AKI (13.5% vs. 4.5%; p-value=0.001) in line with this study.[22]

The current study adds to the sparse body of already published international evidence on the subject and is the first of its sort in the local community. In the present study, we observed that acute STEMI frequently involved middle aged males with concomitant diabetes, hypertension, smoking and obesity. We also observed that a substantial proportion of such patients developed AKI. It was also noticed that this AKI was associated with increased frequency of mortality among such patients irrespective of patient's age, gender, BMI and ASA, diabetic, hypertensive and smoking status and thrombolysis and need for PCI. In the light of this evidence, AKI appears to be an independent predictor of mortality among patients presenting with acute STEMI and warrants routine monitoring of renal function among such patients so that timely identification and anticipated management may improve outcomes of such cases in future practice.

The present study's tight exclusion criteria, stratification of data and large sample size of 128 cases were its strongest points. A biggest limitation of this study was that we didn't consider the effect of various pharmacologic and non-pharmacologic managements of acute kidney injury on the final outcome which could have shed some light on the management planning of such cases. Such a research is essential and is strongly advised for upcoming clinical studies.

CONCLUSION

In the present study, a substantial proportion of patients presenting with acute ST-segment elevation myocardial infarction developed acute kidney injury that was associated with increased frequency of mortality among such patients which warrants routine monitoring of renal function among patients presenting with acute ST-segment elevation myocardial infarction and consideration of cases positive of AKI at higher risk of mortality so that risk stratification and anticipated management may improve the outcome of such patients in future practice.

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