RESEARCH ARTICLE

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Comparison of Outcomes between Early and Late Presentation of ST-elevation Myocardial Infarction in Patients with Cardiogenic Shock

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Abstract

Background and Aim: Cardiogenic shock (CS) arising from ST-elevation myocardial infarction (STEMI) is associated with high mortality. This study aimed to evaluate the clinical characteristics and outcomes of early versus late-present patients with CS complicated with STEMI.

Materials and Methods: This prospective observational study enrolled 92 patients with STEMI and CS from September 2020 to December 2021. Patients were divided into two groups based on the time from symptom onset to hospitalization: early (<24 hours, n=48) and late (≥24 hours, n=44). Demographic data, clinical characteristics, management strategies, and outcomes were compared between the two groups. The Society of Cardiovascular Angiography and Intervention was used to predict mortality between the groups. After one month of discharge outcomes like death, stroke, and non-fatal myocardial infarction were reported.

Results: Most patients were male (70.7%) with a mean age of 63.4±10.9 years. Late presenters were more likely to have lower socioeconomic status and reside in rural areas. The late presentation group had a higher proportion of patients in advanced societies of cardiovascular angiography and intervention stages (D and E) compared with the early group. Late presenters had significantly higher rates of acute kidney injury (72.7% vs. 41.7%, p=0.003) and major adverse cardiovascular events (81.8% vs. 45.8%, p<0.001) at discharge, driven primarily by increased mortality, although the gap in mortality rates narrowed by one month.

Conclusion: Early presentation of STEMI complicated by CS is associated with improved outcomes. Late presenters experienced higher rates of complications and mortality.

Keywords: Management, mortality, myocardial infarction, shock, cardiogenic, ST elevation myocardial infarction

INTRODUCTION

Cardiogenic shock (CS), a severe and life-threatening complication, can stem from various cardiac conditions like fulminant myocarditis, heart failure and cardiomyopathy.[1] CS is a serious complication arising from ST-elevation myocardial infarction (STEMI), occurring in 3-13% of patients. Despite advances in early revascularization techniques and intensive care management, CS remains the primary driver of death rates in STEMI patients.[2] A study by Bagai et al.[3] indicated that patients who experienced CS after an acute myocardial infarction (AMI) had a higher rate of in-hospital mortality compared to patients without CS. The timing of presentation following the onset of symptoms plays a crucial role in determining the prognosis of STEMI complicated by CS. It is crucial to quickly identify CS caused by STEMI to ensure patient survival.[4] It is challenging to classify patients with CS based on the risk or stage of the disease for better management and

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outcomes because they often arrive at the hospital at different stages of the condition.[5] In response to this challenge, the Society of Cardiovascular Angiography and Intervention (SCAI) introduced a novel classification system for CS. This system categorizes patients into five distinct groups with the aim of improving patient management and research outcomes.[6]

In western countries, prompt reperfusion therapy has reduced the time to hospital arrival in STEMI patients. However, limited resources and delayed presentation remain a challenge for developing countries.[7-10] Bridging this gap requires insights into the clinical characteristics and outcomes of early and late presenters. Therefore, our study aimed to evaluate patients with STEMI associated with CS at a tertiary care center. By comparing early and late presenters, we sought to enhance our understanding of disease progression.

MATERIALS AND METHODS

Study Design and Population

This prospective, observational study was conducted from September 2020 to December 2021 at tertiary institutions. The study protocol was approved by the Kasturba Medical College and Kasturba Hospital Institutional Ethics Committee (approval number: 381/2020, date: 10.07.2020) and was registered with the clinical trial registry of India (CTRI/2020/10/028222).

Patients aged 18 years or older who presented to the emergency room with chest pain and were diagnosed with STEMI and CS were included in the study. Exclusion criteria comprised shock unrelated to STEMI, cardiac arrest before hospitalization, pregnancy, terminal illness, advanced malignancy, and inability to document the time of symptom onset. Written informed consent was obtained from all enrolled patients. A total of 92 patients were enrolled and divided into two groups based on the time from symptom onset to hospitalization: 48 patients were early presenters (hospitalized in <24 hours of symptom onset) and 44 patients were late presenters (hospitalized ≥24 hours of symptom onset).

CS was defined as a systolic blood pressure <90 mmHg for at least 30 min or the need for supportive measures to maintain a systolic blood pressure ≥90 mmHg despite adequate filling pressures and signs of end-organ hypoperfusion.

Data Collection

A thorough set of data was collected, including age, gender, social habits, socioeconomic status, area of residence, comorbidities, and family history. The rhythm patterns and blood vessel involvement were evaluated using electrocardiography (ECG) and echocardiography. Patients were managed using emergency medication and different revascularization techniques like cardiopulmonary resuscitation in triage, mechanical ventilation, like coronary artery bypass grafting (CABG), and intra-aortic balloon pump (IABP). Major adverse cardiac events (MACE), considered as a composite of non-fatal MI, stroke, and death, were reported during discharge and at 1-month follow-up.

According to the consensus statement, patients were categorized into one of the five classes outlined in the SCAI classification system for CS; Class A: patients at risk of developing CS, Class B: patients showing early signs of CS, Class C: patients with classic CS, Class D: patients whose condition is deteriorating, and Class E: patients in a critical state.[6]

Management Strategy

The treatment approach involved initial stabilization using inotrope, mechanical ventilation, and/or IABP, followed by revascularization before discharge. The treating physician had discretion over specific treatment choices, including inotropic drug selection, IABP use, and timing of revascularization. Revascularization decisions were influenced by factors such as time from symptom onset, ongoing pain or electrical instability, hemodynamic status, end-organ failure, myocardial viability in the infarct-related artery, presence of mechanical complications, and patient consent. Antiplatelet therapy included aspirin, clopidogrel, ticagrelor, and GP IIb/IIIa inhibitors. Two physicians blinded to patient outcomes analyzed each patient's angiographic profile. Significant stenosis was defined as >70% in the left anterior descending (LAD), right coronary, and left circumflex arteries and >50% in the left main coronary artery. Patients were monitored throughout their hospital stay. The median time to appropriate care was 18 hours in the present study.

Statistical Analysis

Data were analyzed using SPSS version 20. Categorical variables are reported as proportions, and continuous variables are reported as mean ± standard deviation. The chi-square test and Student's t-test were employed for the statistical analysis of categorial and continuous variables, respectively. Statistical significance was defined as a *P*-value of 0.05.

RESULTS

The study involved a total of 92 patients, with 48 and 44 patients in the early presentation group (<24 hours) and 44 patients in the late presentation group (≥24 hours). Most patients were male (70.7%) and the average age was 63.4±10.9 years. There was a significant difference in socioeconomic status between the early and late groups, with more patients from the upper middle class in the early group (50.0%) and more patients from the lower class in the late group (40.9%). Similarly, there was a significant difference in terms of area of residence,

with a higher proportion of rural patients in the late group (54.5%) than in the early group (20.8%). Almost all patients (98.9%) presented with chest pain, whereas fewer patients experienced breathlessness (30.4%) and giddiness/syncope (13.0%). Comorbidities such as dyslipidemia, diabetes mellitus, hypertension, thyroid disorders, stroke, and peripheral arterial disease were prevalent in both groups. Regarding mentation, a significant difference was observed between the early and late groups, with more patients being disoriented (70.5%) in the late group than in the early group (18.8%). Table 1 presents the baseline demographic and clinical characteristics of early and late presenters of STEMI complicated with CS.

Among overall patients, the mean left ventricular ejection fraction (LVEF) was 36.9%. In the early group, 19 (39.6%) patients had right ventricular infarction, whereas 14 (31.8%) patients in the late group suffered from the same condition. In terms of MI types, anterior wall MI was the most common, affecting 55.4% of all patients. It was more prevalent in the late group (65.9%) than in the early group (45.8%). Inferior wall MI was the second most common presentation, occurring in 33.7% of all patients, with a higher frequency in the early group (39.6%) than in the late group (27.3%). The percentage of patients who received mechanical ventilation support was higher in the early (43.8%) and late (88.6%) groups than in other revascularization techniques like CABG and IABP, which was statistically significant. The median lactate level was 40.2 mg/dL, and the median troponin T level upon arrival was 0.92 ng/mL. The serum creatinine level was elevated at 2.16 mg/dL at the time of discharge in all patients. The SCAI classification of CS showed that the late group had a higher percentage of patients in stage D (45.5%) and stage E (31.8%) compared with the early group (stage D: 33.3%, stage E: 18.8%). There were no patients from the study falling under stages A and B of the SCAI classification for CS. Tables 2 and 3 present the anthropometric, laboratory investigations, and management of early vs late presenters of STEMI complicated with CS. The median time to symptom onset for appropriate care was 18 h in the present study.

Table 1: Baseline demographics and clinical characteristics of early and late presenters of cardiogenic shock complicating STEMI

Variables	Total (n=92 patients)	Early (<24 hours) (n=48 patients)	Late (≥24 hours) (n=44 patients)	*P*-value
Male, n (%)	65 (70.7)	37 (77.1)	28 (63.6)	0.176
Age, years	63.4±10.9	63.9±10.5	62.7±11.5	0.620
Social habits				
Smoker, n (%)	36 (39.1)	18 (37.5)	18 (40.9)	0.831
Alcoholic, n (%)	13 (14.1)	7 (14.6)	6 (13.6)	1.000
Tobacco chewing frequency, n (%)	17 (18.5)	5 (10.4)	12 (27.3)	0.057
Socioeconomic status				
Lower, n (%)	24 (26.1)	6 (12.5)	18 (40.9)	<0.001
Upper lower, n (%)	22 (23.9)	9 (18.8)	13 (29.5)	
Lower middle, n (%)	17 (18.5)	9 (18.8)	8 (18.2)	
Upper middle, n (%)	29 (31.5)	24 (50.0)	5 (11.4)	
Area of living				
Rural, n (%)	34 (37.0)	10 (20.8)	24 (54.5)	0.003
Semiurban, n (%)	36 (39.1)	23 (47.9)	13 (29.5)	
Urban, n (%)	22 (23.9)	15 (31.3)	7 (15.9)	
Comorbidities				
Dyslipidemia, n (%)	10 (10.9)	6 (12.5)	4 (9.1)	0.742
Diabetes mellitus, n (%)	51 (55.4)	29 (60.4)	22 (50.0)	0.402
Hypertension, n (%)	50 (54.3)	25 (52.1)	25 (52.1)	0.680
Thyroid disorders, n (%)	7 (7.6)	1 (2.1)	6 (13.6)	0.051
Stroke, n (%)	4 (4.3)	2 (4.2)	2 (4.5)	1.000
Peripheral arterial disease, n (%)	3 (3.3)	0 (0.0)	3 (6.8)	0.105
Family history, n (%)	8 (8.7)	5 (10.4)	3 (6.8)	0.716

STEMI: ST-elevation myocardial infarction

Table 2: Anthropometric and laboratory investigations of early and late presenters of cardiogenic shock that complicate STEMI

Variables	Total (n=92 patients)	Early (<24 hours) (n=48 patients)	Late (≥24 hours) (n=44 patients)	*P*-value
ECG rhythmic presentations				
Sinus rhythm, n (%)	66 (73.8)	30 (62.5)	36 (81.8)	0.129
Atrial fibrillation, n (%)	9 (9.8)	6 (12.5)	3 (6.8)	
Heart blocks, n (%)	17 (18.5)	12 (25.0)	5 (11.4)	
MI				
Inferior posterior wall MI, n (%)	10 (10.9)	7 (14.6)	3 (6.8)	0.137
Anterior wall MI, n (%)	51 (55.4)	22 (45.8)	29 (65.9)	0.137
Inferior wall MI, n (%)	31 (33.7)	19 (39.6)	12 (27.3)	0.137
Right ventricular infarction, n (%)	33 (35.9)	19 (39.6)	14 (31.8)	0.516
SCAI stages of cardiogenic shock				
Stage C, n (%)	33 (35.9)	23 (47.9)	10 (22.7)	0.39
Stage D, n (%)	36 (39.1)	16 (33.3)	20 (45.5)	
Stage E, n (%)	23 (25.0)	9 (18.8)	14 (31.8)	
Coronary angiographic findings				
Vessel involvement				
Single vessel disease, n (%)	27 (29.3)	17 (35.4)	10 (22.7)	0.006
Double vessel disease, n (%)	22 (23.9)	14 (29.2)	8 (18.2)	
Multivessel disease, n (%)	34 (36.9)	17 (35.4)	17 (38.8)	
Culprit vessel				
Right coronary artery, n (%)	34 (36.9)	25 (52.1)	9 (19.7)	<0.001
Left anterior descending artery, n (%)	58 (63.0)	33 (68.7)	25 (56.8)	0.122
Left circumflex artery, n (%)	15 (16.3)	13 (26.6)	2 (4.5)	0.039

STEMI: ST-elevation myocardial infarction, MI: Myocardial infarction, ECG: Electrocardiogram, SCAI: Society for cardiovascular angiography and intervention

Table 3: Management of early and late presenters of cardiogenic shock that complicates STEMI

Variables	Total (n=92 patients)	Early (<24 hours) (n=48 patients)	Late (≥24 hours) (n=44 patients)	*P*-value
Emergency management				
Noradrenaline, n (%)	67 (72.8)	43 (89.6)	24 (54.5)	<0.001
Noradrenaline and adrenaline, n (%)	25 (26.2)	5 (10.4)	20 (45.5)	
Oral medication				
Aspirin, n (%)	92 (100)	48 (100)	44 (100)	0.944
Ticagrelor, n (%)	79 (85.9)	45 (93.8)	34 (77.3)	0.035
Clopidogrel, n (%)	13 (14.1)	2 (4.2)	11 (25)	0.006
GP IIb/IIa inhibitors, n (%)	14 (15.2)	11 (22.9)	3 (6.8)	0.042
Revascularization				
Cardiopulmonary resuscitation during triage, n (%)	30 (32.6)	5 (10.4)	25 (56.8)	<0.001
Mechanical ventilation support, n (%)	60 (65.2)	21 (43.8)	39 (88.6)	<0.001
IABP, n (%)	38 (41.3)	17 (35.4)	21 (47.7)	0.291
CABG, n (%)	9 (9.8)	3 (6.3)	6 (13.6)	0.302
PCI, n (%)	83 (91.2)	45 (93.7)	38 (86.4)	0.206

STEMI: ST-elevation myocardial infarction, CABG: Coronary artery bypass graft surgery, IABP: Intra-aortic balloon pump, PCI: Percutaneous coronary intervention

The clinical outcomes of early and late CS patients with STEMI are described in Table 4. Late presentation was associated with significantly higher rates of acute kidney injury (n=32, 72.7%) and in-hospital MACE (n=36, 81.8%), driven primarily by increased in-hospital mortality (n=34, 77.3%) followed by stroke (n=2, 4.5%), although by one month the gap in mortality rates between the two groups had narrowed. Mortality one month after discharge was (2.1%) and in late group (4.5%).

DISCUSSION

CS is the primary cause of mortality among patients hospitalized with AMI. Although a paucity of studies have investigated the timing of CS during AMI hospitalization, none have examined the changing trends in the extent of CS based on the timing of its occurrence. The present study data for patients with early and late presentation of STEMI associated with CS are consistent with the findings from previous studies, which demonstrated a decline in the incidence of adverse outcomes in patients with AMI complicated by CS over time, attributable to earlier hospital presentation.[11,12]

Advanced age, hypertension, diabetes, and smoking are strong predictors of in-hospital mortality among patients who develop CS after AMI and require immediate management.[13] Singh et al.[14] in their study also found a positive association between these factors and higher mortality rates. Nguyen et al.[15] found that older age, presence of diabetes, and presentation with STEMI increased the likelihood of developing complication. However, the present study did not reveal a significant difference in the prevalence of diabetes, hypertension, and smoking between early and late presenters.

In the present study, the mean LVEF was 36.9%, and the early group had a greater number of patients (n=19) with right ventricular infarction. On the other hand, anterior MI was more prevalent among patients in the late group (65.9%) than in the early group. Additionally, both groups exhibited a greater number of patients with multivessel coronary artery disease involvement. Similarly, a study comparing the incidence and outcomes of CS in anterior versus inferior STEMI found that anterior STEMI was more frequently complicated by CS and associated with higher in-hospital mortality.[16] Left ventricular dysfunction is implicated in most CS cases associated with STEMI, and ECG findings are often consistent with recent total occlusion of the LAD artery. The SHOCK trial investigators observed that the predominant cause of CS was left ventricular failure, accounting for 78.5% of all cases assessed in the study.[17]

The SCAI classification system for CS aimed to establish a standardized assessment of disease severity in affected patients, thereby enabling the evaluation of mortality risk associated with varying degrees of the condition.[6] The SCAI classification effectively separated patients with CS into distinct risk categories when applied to an unbiased clinical cohort in the study.[5] Jentzer et al.[18] applied the SCAI CS classification to an unselected cohort of patients and found that it was independently associated with in-hospital mortality. In our study, we observed that most patients in the late group were classified into SCAI stage D (45.5%) and stage E (31.8%). When relating these stages to mortality outcomes, patients in the late group experienced higher in-hospital mortality rates (77.3%) compared with the early group (16.7%), suggesting that advanced SCAI stages correlate with increased mortality risk.

Management and Outcomes

The American Heart Association recommends a stepwise treatment strategy for patients with CS associated with STEMI, beginning with the administration of vasoactive medications followed by the insertion of percutaneous mechanical circulatory support devices if vasoactive medications fail to improve hemodynamic.[19,20] The practice guidelines from both the American and European medical authorities indicate that the use of IABP can be considered a potential intervention. Its purpose is to reduce the afterload

Table 4: Outcomes of early and late presenters of cardiogenic shock that complicate STEMI

Variables	Total (n=92 patients)	Early (<24 hours) (n=48 patients)	Late (≥24 hours) (n=44 patients)	*P*-value
In-hospital AKI, n (%)	50 (54.3)	18 (37.5)	32 (72.7)	0.001
In-hospital MACE				
In- hospital non-fatal MI, n (%)	1 (1.1)	1 (2.1)	0 (0.0)	1.000
In-hospital stroke, n (%)	3 (3.3)	1 (2.1)	2 (4.5)	0.605
In-hospital mortality, n (%)	42 (45.6)	8 (16.7)	34 (77.3)	<0.001
MACE 1 month after discharge				
Nonfatal MI, n (%)	2 (2.2)	2 (5.0)	0 (0.0)	1.000
Stroke, n (%)	1 (1.1)	0 (0.0)	1 (2.3)	1.000
Death by number (%)	3 (3.3)	1 (2.1)	2 (4.5)	0.387

STEMI: ST-elevation myocardial infarction, AKI: Acute kidney injury, MACE: Major adverse cardiac events, MI: Myocardial infarction

on the left ventricle and attempt to stabilize the hemodynamic conditions in patients experiencing mechanical complications arising from AMI.[20,21] IABP may provide a mortality benefit for patients experiencing rapidly decompensating and severe CS.[4] Earlier research has proposed that the downward trajectory of mortality rates among patients with CS arising from AMI can be primarily ascribed to the prompt use of balloon pump devices and the administration of evidence-backed pharmacological interventions.[15] In our study, a higher number of patients in the late group underwent IABP (47.7%), CABG (13.6%), mechanical ventilation (88.6%), and cardiopulmonary resuscitations (56.8%). Whereas 93.7% underwent percutaneous coronary intervention in the early group. Despite the extensive efforts to develop and implement novel therapeutic approaches for CS in the context of AMI, the prognosis for patients afflicted with this condition has remained largely unchanged, with a staggering mortality rate where one out of every two patients succumbs to the condition.[22] A study by Hashmi et al.[13] observed a high frequency (44.73%) of in-hospital mortality among patients who developed CS after AMI. Despite adhering to the guidelines for management and having similar frequencies of factors affecting the condition in both groups, the mortality rate was higher among the late group. These findings underscore the importance of early hospital presentation to improve outcomes.

Study Limitations

This study has several limitations that should be considered. This was a single-center study with a relatively small sample size, which may limit the generalizability of the findings to a wider population. The follow-up period of 1 month may have been insufficient to capture long-term outcomes and the potential impact of late presentation on long-term prognosis. Therefore, larger multi-center studies with longer follow-up periods are warranted to validate the findings and explore the long-term implications of delayed presentation on outcomes and quality of life.

CONCLUSION

The current study underscores the critical importance of early presentation in STEMI complicated by CS. Late presenters experienced significantly worse outcomes, including higher rates of acute kidney injury, MACE, and in-hospital mortality. Socioeconomic factors and rural residence were associated with delayed presentation, highlighting the need for targeted interventions to improve healthcare access and awareness.

Ethics

Ethics Committee Approval: The study protocol was approved by the Kasturba Medical College and Kasturba Hospital Institutional Ethics Committee (approval number: 381/2020, date: 10.07.2020).

Informed Consent: Written informed consent was obtained from all enrolled patients.

Authorship Contributions

Surgical and Medical Practices: N.S., T.D., Concept: N.S., T.D., Design: T.D., Data Collection or Processing: N.S., Analysis or Interpretation: N.S., T.D., Literature Search: N.S., T.D., Writing: N.S., T.D.

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