Original Article

In-Hospital Outcome of STEMI Patients With or Without Coronavirus Disease 2019

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Abstract

Introduction: The exact mechanism of cardiac involvementremains unclear in coronavirus disease 2019 (COVID-19).ST-segment elevation myocardial infarction (STEMI) may be a first clinical manifestation of COVID-19 or there may be simultaneous presentation of STEMI & COVID-19.This study aimed to compare demographics, clinical presentation, treatment and in-hospital outcome of STEMI patients with COVID-19 or without COVID-19.

Methods: This prospective observational study was carried out at National Heart Foundation Hospital & Research Institute of Bangladesh between the periods of 08 March 2020 and 07 March 2021. All admitted STEMI patients, who become COVID-positive and without COVID-19 were included in this study. COVID-19 was confirmed with reverse transcription–polymerase chain reaction assays.

Results: A total of 1146 STEMI patients with (103) or without (1043) COVID-19 were admitted during this period. Mean age of the patients with COVID-19 was 54.87±12.77 years and without COVID-19 was 54.34±10.87 years. Male patients were predominant in both groups (85.4% vs 87.4%). History of coronary artery disease (24.3% vs 5.8%; p=0.001) and smoking (65.0% vs 51.7%; p=0.01) were prevalent in patients with COVID-19. Dyslipidemia (80.7% vs 69.9%;p=0.009) was more prevalent in patients without COVID-19. Only 22.3% (23) STEMI patients COVID-19 and 64.9% (677) STEMI patients without COVID-19 underwent coronary angiography. STEMI patients with COVID-19 had more triple vessel disease and non-significant coronary stenosis. STEMI patients with COVID-19 received more medical treatment (69.9% vs 41.2%) and less coronary intervention (10.7% vs 40.5%). Acute left ventricular failure (23.3% vs 18.4%; p=0.04) and cardiogenic shock (10.7% vs 6.7%; p=0.4) were prevalent in STEMI patients with COVID-19. Mortality rate was higher (9.7% vs 2%; p=0.03) in STEMI patients with COVID-19.

Conclusion: STEMI patients with COVID-19 represent high risk population and associated with higher morbidity and mortality than without COVID-19.

Keywords: STEMI, demographics, clinical features, treatment, COVID-19, in-hospital outcome.

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Introduction

The global outbreak of coronavirus disease 2019 (COVID-19), caused by the novel RNA virus SARS-CoV-2, has primarily been recognized for its impact on the respiratory system. However, due to the widespread distribution of angiotensin-converting enzyme 2 (ACE2) receptors-which serve as the entry point for the virus-other organs such as the heart, kidneys, gastrointestinal tract, and vascular endothelium can also be affected [1]. Cardiac complications associated with COVID-19 have been linked to increased rates of morbidity and mortality. Within the myocardium, SARS-CoV-2 may target pericytes, cardiomyocytes, fibroblasts, and resident immune cells such as macrophages [2]. Although the precise pathways of cardiac involvement are not fully understood, two primary mechanisms have been proposed. First, myocardial injury may result from a systemic inflammatory response or "cytokine storm," characterized by elevated markers such as interleukin-6 (IL-6), ferritin, lactate dehydrogenase (LDH), and D-dimer. Second, the virus may directly impair cardiac function by infecting heart tissue [3]. In some patients, ST-segment elevation myocardial infarction (STEMI) may be the initial clinical manifestation of COVID-19, while in others, it occurs concurrently. Differentiating between a primary coronary event and COVID-19-related myocardial injury can be challenging, particularly in the absence of coronary angiography. During the pandemic, the use of angiography has been limited due to concerns about viral transmission, complicating accurate diagnosis [4]. In a notable proportion-up to 39.3%-no culprit lesion is found, ruling out type 1 myocardial infarction in many cases [5].

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Evidence suggests that STEMI patients with concurrent COVID-19 infection experience worse clinical outcomes compared to those without the virus. This study aims to evaluate and compare the demographic profiles, treatment approaches, and clinical outcomes of STEMI patients with and without COVID-19.

Methods & Materials

Study Design, Setting, and Population

This prospective observational study was conducted at the non-COVID tertiary cardiac care hospital (National Heart Foundation Hospital & Research Institute, Dhaka, Bangladesh) from March 08, 2020 to March 07, 2021. All admitted STEMI patients, who become COVID-positive and without COVID-19 were included in this study. The study was approved by the Ethics Review Committee of National Heart Foundation Hospital & RI (N.H.F.H. & R.I. 4-14/7/ad./1316) and written informed consent was obtained from all patients.

Definition and variables

ST-segment elevation myocardial infarction (STEMI) was identified based on the presence of characteristic symptoms in conjunction with ST-segment elevation on an electrocardiogram or the appearance of a new left bundle-branch block [6]. COVID-19 infection was confirmed through a positive result from a real-time reverse transcription polymerase chain reaction (RT-PCR) test performed on nasopharyngeal swab samples [7]. A coronary lesion was labeled as the culprit if angiographic imaging revealed thrombotic occlusion or near-occlusion [5]. Obstructive coronary artery disease was defined as the presence of a coronary artery stenosis greater than 50% based on visual assessment during angiography [5]. Demographic data collected included age, sex, and cardiovascular risk factors or comorbid conditions such as diabetes mellitus, hypertension, smoking history, dyslipidemia, family history of ischemic heart disease, obesity, cerebrovascular disease, chronic kidney disease, chronic respiratory diseases like chronic obstructive pulmonary disease (COPD) or bronchial asthma (BA), and pregnancy status. COVID-19 severity was categorized into four levels: mild, moderate, severe, and critically ill, as per established clinical criteria [8,9]. A mild case involved minimal clinical symptoms without radiologic evidence of pneumonia. Moderate cases showed symptoms such as fever or respiratory complaints, alongside imaging-confirmed pneumonia. Severe illness was identified by one or more of the following: a respiratory rate of ≥30 breaths per minute, oxygen saturation ≤93% at rest, or rapid radiographic progression (infiltrate increase >50%) within 24–48 hours. Critical illness was defined by the need for mechanical ventilation due to respiratory failure, the presence of shock, or multi-organ dysfunction requiring intensive care unit (ICU) support [8,9]. The case fatality rate (CFR) was calculated by dividing the total number of confirmed deaths by the number of laboratory-verified COVID-19 cases, expressed as a percentage [10].

Statistical Analysis

Continuous variables are described using the mean and standard deviation (SD), and compared using unpaired student's 't' test. Discrete variables were expressed as frequency rates and percentage. Categorical variables between groups were compared using the chi-square test or Fisher's exact test. A p value <0.05 was considered statistically significant. All analyses were performed using SPSS statistical software version 16.0 (SPSS Inc., Chicago, IL, USA).

Results

During this period a total of 1146STEMI patients were enrolled. Of whom 103 (9%) patients were with COVID-19& 1043 (91%) were without COVID-19. The mean age of the patients with COVID-19was 54.87 ±12.77 years and patients without COVID-19 was 54.34 ± 10.87 years (p=0.64).Male were predominant in both groups (85.4% vs 14.6% and 87.4% vs 12.6%; p=0.56).History of coronary artery disease (CAD) (24.3% vs 5.8%; p=0.001) and smoking (65.0% vs 51.7%; p=0.01) were prevalent in patients with COVID-19.Dyslipidemia (80.7% vs 69.9%;p=0.009) was more prevalent in patients without COVID-19. Baseline characteristics of STEMI patients with and without COVID-19 are presented in Table 1.

Table 1: Demographic & clinical characteristics of STEMI patients with and without COVID-19 (n-1146)

Variables	With COVID-19 (n=103)	Without COVID-19 (n=1043)	p value
	Mean±SD/f(%)	Mean±SD/f(%)	
Age (Mean±SD) year	54.87 ±12.77	54.34 ± 10.87	0.64#
Gender			
• Male	88(85.4%)	912(87.4%)	0.56*
• Female	15(14.6%)	131(12.6%)	
Risk factors & comorbidities			
Smoking	67(65.0%)	539(51.7%)	0.01*
HTN	65(63.1%)	680(65.2%)	0.67*
DM	64(62.1%)	701(67.2%)	0.29*
Dyslipidemia	72(69.9%)	842(80.7%)	0.009*
Family H/O IHD	23(22.3%)	247(23.7%)	0.75*
H/O CAD	25(24.3%)	60(5.8%)	0.001*
Obesity	37(35.9%)	360(34.5%)	0.77*
CKD	48(46.6%)	422(40.5%)	0.22*
Left ventricular ejection fraction (Mean ± SD)%	44.86 ± 8.3	44.0 ± 7.6	0.27*

COVID-19: coronavirus disease 2019; SD: standard deviation; HTN: hypertension; DM: diabetes mellitus; H/O: history of; IHD: ischemic heart disease; CAD: coronary artery disease; CKD: chronic kidney disease. *Chi square test was done to find out the significance; #Student's 't' test was done to find out the significance.

STEMI patients with COVID-19 underwent less coronary angiography (CAG) (22.3% vs 64.9%; p=0.001) (Table: 2). Single vessel disease (SVD) (49.5% vs 39.1%) & double vessel disease (DVD) (27.8% vs 21.7%) were more common in patients without COVID-19 and triple vessel disease (TVD) (26.2% vs 19.4%) & normal coronary artery (13.0% vs 3.4%) were more common in patients with

COVID-19. In the COVID-19 era, most of the STEMI patients with COVID-19 received medical management (69.9% vs 41.2%). Only 10.7% COVID-19 patients underwent invasive treatment {pharmaco-invasive therapy (PIT) and percutaneous coronary intervention (PCI) only}. On the other hand, 40.5% patients without COVID-19 underwent invasive treatment (PIT, primary PCI and PCI only).

Table 2: Procedural characteristics of STEMI patients with and without COVID-19 (n-1146)

Variables	With COVID-19 (n=103)	Without COVID-19 (n=1043)	p value
	n(%)	n(%)	
Coronary angiography	23(22.3%)	677(64.9%)	0.001*
SVD	09(39.1%)	335(49.4%)	0.32*
DVD	05(21.7%)	188(27.8%)	0.52*
TVD	06(26.2%)	131(19.4%)	0.42*
Normal	03(13.0%)	23(3.4%)	0.01*
Treatment option			
Thrombolytic therapy only	20(19.4%)	191(18.3%)	0.78*
Primary PCI	00(0.0%)	12(1.2%)	0.27*
Pharmaco-invasive therapy	04(3.9%)	128(12.3%)	0.01*
PCI only	07(6.8%)	282(27.0%)	0.001*
Medical management	72(69.9%)	430(41.2%)	0.001*

COVID-19: coronavirus disease 2019; SVD: single vessel disease; DVD: double vessel disease; TVD: triple vessel disease; PCI: percutaneous coronary intervention. *Chi square test was done to find out the significance.

In-hospital outcome was worse for STEMI patients with COVID-19 than patients without COVID-19. Acute left ventricular failure (23.3% vs 18.4%; p=0.22) and cardiogenic shock (10.7% vs 6.7%; p=0.13) developed more in patients with COVID-19. In-hospital death was significantly higher in patients with COVID-19 (9.7% vs 1.2%; p=0.001).

Table 3: In-hospital outcome of STEMI patients with and without COVID-19 (n-1146)

Variables	With COVID-19 (n=103)	Without COVID-19 (n=1043)	p value
	n(%)	n(%)	
Cardiogenic shock	11(10.7%)	70(6.7%)	0.13*
Acute LVF	24(23.3%)	192(18.4%)	0.22*
Arrhythmias	05(4.9%)	93(8.9%)	0.16*
Death	10(9.7%)	13(1.2%)	0.001*

COVID-19: coronavirus disease 2019; LVF: left ventricular failure. *Chi square test was done to find out the significance.

Discussion

This study yielded several key findings: (1) STEMI patients with COVID-19 were less likely to undergo invasive procedures; (2) they were more frequently managed with medical therapy; and (3) these patients experienced worse clinical outcomes compared to those without COVID-19.

The underlying mechanisms linking COVID-19 to STEMI are not yet fully clarified, but several hypotheses have been proposed. These include plaque destabilization triggered by heightened systemic inflammation, a hypercoagulable state marked by elevated procoagulants, impaired fibrinolytic activity, and endothelial dysfunction [11]. Additionally, alterations in myocardial oxygen supply and demand, even in the absence of significant atherosclerotic disease, can precipitate type 2 myocardial infarction [12,13]. Microvascular thrombotic events have also been documented in the context of COVID-19 and may further contribute to myocardial impairment in both obstructive and non-obstructive coronary disease [14,15].

In our cohort of 1,146 STEMI patients, 103 (9%) were COVID-19 positive. The average age was similar across both groups (approximately 54 years), and men predominated in both (85.4% vs. 87.4%). Among COVID-19 patients, a higher prevalence of prior coronary artery disease and smoking history was noted, while dyslipidemia was more frequently observed in those without the infection. Choudry et al. [16] evaluated 115 STEMI patients treated with primary PCI in the UK, with 33.9% testing positive for COVID-19. While the mean age and gender distribution were similar across groups, their cohort was slightly older than ours. Patients with COVID-19 had a higher prevalence of diabetes, hypertension, hyperlipidemia, and prior PCI, and they were also more likely to experience cardiac arrest.

Rodriguez-Leor et al. [17] analyzed data from over 1,000 STEMI patients in Spain, finding a similar COVID-19 positivity rate of 9%. Although demographic characteristics were largely comparable between groups, patients with COVID-19 more frequently presented with heart failure. Smoking was more prevalent among non-COVID-19 patients, while those with COVID-19 had a higher rate of previous coronary disease.

Saad et al. [18] reviewed 4,015 STEMI cases, 359 of whom were COVID-19 positive. No significant age difference was noted, but men and cardiac arrest were more common in the COVID-19 group. Interestingly, fewer COVID-19 patients presented with heart failure. The NACMI (North American COVID-19 Myocardial Infarction) registry [19], a multicenter prospective database, included over 1,100 STEMI patients with either confirmed or suspected COVID-19. Infected patients were more likely to be male, older, diabetic, and to present with cardiogenic shock compared to non-infected controls.

Various cardiology societies issued differing recommendations for reperfusion strategies during the pandemic, adapting to resource constraints and exposure risks [20]. The American College of Cardiology and the Society for Cardiovascular Angiography & Interventions suggested thrombolysis could be appropriate for stable COVID-19 positive STEMI patients to minimize staff exposure [21]. In Bangladesh, the Bangladesh Society of Cardiovascular Interventions advised thrombolytic therapy

in the absence of dedicated COVID-19 catheterization labs [22]. Following this national guidance, our institution administered thrombolytics as the primary reperfusion strategy for all COVID-19 positive STEMI patients.

In our study, STEMI patients with COVID-19 underwent less CAG (22.3% vs 64.9%; p=0.001). SVD & DVD were more common in patients without COVID-19 and TVD & normal coronary artery were more common in patients with COVID-19. In the COVID-19 era, most of the STEMI patients with COVID-19 received medical management (69.9% vs 41.2%). Only 10.7% COVID-19 patients underwent invasive treatment PIT and PCI only. On the other hand, 40.5% patients without COVID-19 underwent invasive treatment (PIT, primary PCI and PCI only). In contrast to our study, Choudry et al. [16] showed that all their study patients underwent a primary PCI procedure in both groups. Median door-to-balloon times were within 60 min and similar for both groups. There was evidence of higher thrombogenicity in the COVID-19 group with significantly higher rates of multivessel thrombosis and stent thrombosis. Rodriguez-Leor et al. [17] showed in patients with COVID-19- 60.4% had SVD; 24.2% DVD and 13.2% TVD and in patients without COVID-19- 60.3%, 28.2% and 8.9% respectively. Around twelve percent (11.9%) STEMI patients with COVID-19 and 8.2% patients without COVID-19 did not have significant coronary stenosis. Most of the patients in both groups underwent primary PCI (97.8% vs 94.8%). Patients with COVID-19 were significantly more likely to receive fibrinolytics as standalone therapy (8.1% vs 1.0%), but significantly less likely to undergo coronary angiography(30.4%vs 50.8%), any PCI (22.8%vs 36.5%), or coronary artery bypass grafting (0.3% vs 7.3%) compared with those without COVID-19 [18]. In NACMI registry, out of 230 STEMI patients with COVID-19, 179 (78%) underwent CAG and 127 (71% of patients undergoing CAG) received PPCI [19]. Other reperfusion strategies included facilitated or rescue PCI (7, 4%), thrombolytic therapy (3%), and coronary artery bypass grafting surgery (3, 2%). Among the 179 patients who underwent CAG, 36 (20%) received medical management alone without reperfusion. In contrast, age and sex-matched control patients were more likely to receive PPCI (93%) and less likely to receive medical management alone (2%).

In-hospital outcome was worse for STEMI patients with COVID-19 than patients without COVID-19. Acute left ventricular failure and cardiogenic shock developed more in patients with COVID-19. In-hospital death was significantly higher in patients with COVID-19 (9.7% vs 1.2%; p=0.001). Higher mortality rate was also observed in different studies [16-19]. STEMI patients with COVID-19 had significantly longer in-patient stays and were more likely to require intensive care, reflecting a greater level of morbidity in this STEMI cohort. However, despite numerically higher rates of in-hospital mortality among the COVID-19 STEMI patients, this did not reach significance (17.9% vs.6.5%, p=0.10) [16]. STEMI patients COVID-19 had an increased in-hospital mortality (23.1% vs 5.7%, p<0.0001), that remained consistent after adjustment for age, sex, Killip class and ischemic time [17]. For those with STEMI and COVID-19, in-hospital mortality was 78.5% vs 46.1% for those without COVID [18]. Patients with STEMI and COVID-19 had the highest rates of in-hospital mortality (33% vs. 11% vs. 4%; p< .001) [19].

Limitation

Our study has several limitations. Firstly, study conducted in non-COVID-dedicated cardiac hospital. Secondly, biochemical markers indicating severity of COVID-19 was not assessed for all patients. Thirdly, Chest CT was not done for all patients.

Conclusion

Among all STEMI patients, only 9% STEMI patients infected with COVID-19. STEMI patients with COVID-19 underwent three times less coronary angiography than their counterpart. They received medical management 1.5 times higher and invasive treatment four times lesser than patients without COVID-19. STEMI with a concomitant diagnosis of COVID-19 is associated with higher rates of morbidity and in-hospital mortality vs STEMI without COVID-19.

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