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Research Paper

Comparing Clinical Parameters and Outcomes of ST-elevation Myocardial Infarction (STEMI) Patients With and Without COVID-19 Infection

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ABSTRACT

Objectives: During the novel coronavirus disease 2019 (COVID-19) pandemic, the incidence of cardiovascular diseases increased. In this context, diagnosing ST-elevation myocardial infarction (STEMI) in COVID-19 cases has become complex and challenging.

Objectives: This study explored the characteristics and compared clinical outcomes between COVID-19 and non-COVID-19 patients with STEMI.

Methods: This prospective observational study was conducted on adult patients admitted with the diagnosis of STEMI in the first 6 months of the pandemic. Patients were evaluated for COVID-19 diagnosis and divided into two groups: COVID-19-positive and COVID-19-negative. Then, they were monitored during hospitalization and 6 months after discharge.

Results: Of 131 patients admitted with STEMI, 22.13% had COVID-19 infection. Most patients were men, and the COVID-19-positive patients were older than non-infected patients (63.97±12.54 vs 58.19±10.97 years; P=0.039). The COVID-19-infected patients had a higher prevalence of diabetes (P=0.003) and heart failure (P=0.008). They had higher levels of erythrocyte sedimentation rate (ESR) (P=0.003) and neutrophil count (P=0.018), whereas lymphocyte count declined considerably in these patients (P=0.012). In addition, hospital length of stay was higher in the infected patients (6.64±4.30 vs 4.93±3.59 days; P=0.023). During the study period, the overall mortality rate in our setting was 8.82% and 17.24% in COVID-19-negative and -positive patients, respectively. However, this difference was not statistically significant (P=0.195).

Discussion: Although the current study employed a small sample, the findings suggest notable differences between the STEMI patients with and without COVID-19 infection regarding some parameters, especially underlying comorbidities. However, the difference in mortality was not significant.

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Introduction

The novel coronavirus disease 2019 (COVID-19) emerged in Wuhan, China, in December 2019, rapidly evolving into a global pandemic. During the COVID-19 pandemic, the incidence of cardiovascular diseases, including acute coronary syndromes (ACS), stress-induced cardiomyopathy, arrhythmias, and myocarditis, increased [1].

Several mechanisms have been proposed for the pathogenesis of COVID-19 in myocardial injuries. These mechanisms include cytotoxic effect and endothelial damage by angiotensin–converting enzyme 2 (ACE-2) receptor expressed in the myocytes, coronary microvascular obstruction owing to hyperinflammation and prothrombotic state, a mismatch of myocardial supply and demand due to cytokine storm, and acute respiratory distress syndrome (ARDS) associated hypoxemia [2, 3].

The COVID-19 outbreak negatively influences admission rates and the reperfusion strategy for patients with ST-elevation myocardial injury (STEMI) worldwide [4]. Declining admission rates of STEMI patients with COVID-19 and a delay in symptom onset to first medical contact or door-to-balloon have been reported in this population [5, 6]. Additionally, the definition and diagnosis of STEMI in COVID-19 cases have been complex and challenging due to factors such as social distancing, lockdown, health care burden due to the COVID-19 pandemic, and unclear diagnosis of heart attack [4, 5].

Objectives

We designed this study to compare the characteristics, management, and clinical outcomes of patients with STEMI with and without COVID-19.

Materials and Methods

Settings and study population

This prospective observational study was conducted on adult patients diagnosed with STEMI at the Imam Hossein Medical Center, affiliated with Shahid Beheshti University of Medical Sciences (SBMU) in Tehran City, Iran, in the first 6 months of the pandemic, spanning from February 2020 to August 2020.

Assessments

All enrolled patients were evaluated for COVID-19 infection based on reverse transcription polymerase chain reaction (RT-PCR), typical clinical features, and computerized tomography (CT) scan results. Also, STEMI was defined according to the universal definition of myocardial infarction (MI) [7]. All infected patients were managed according to standard treatment protocol based on the updated World Health Organization (WHO) guideline treatment.

Patients were divided into two groups: COVID-19-positive and COVID-19-negative. Then, they were monitored during hospitalization and 6 months after discharge by telephone call. The study data, including baseline characteristics, comorbid risk factors, drug history, clinical and laboratory data, and outcomes, were recorded and compared between the two groups.

Statistical analysis

All statistical analyses were performed using SPSS software, version 21 for Windows (SPSS Inc., Chicago, IL, USA). A $P<0.05$ was considered statistically significant.

Quantitative data were tested for normality by the Kolmogorov-Smirnov test and then compared by the unpaired t and Mann-Whitney U tests for normally and non-normally distributed data, respectively. Qualitative data were analyzed by the chi-squared or Fisher exact test. The data were presented as Mean±SD or median (percentile, Q1, Q3) for normal and non-normal distributed quantitative data, respectively, and n (%) for qualitative data.

Results

During the period of the study, 131 patients were admitted with STEMI. of whom, 29 patients (22.13%) were diagnosed with COVID-19. None had an RT-PCR result at admission, but they had typical clinical features and CT scan results of COVID-19 infection.

All patients underwent primary angioplasty upon admission, except for 12 patients who initially received thrombolytic treatment (10 and 2 in the COVID-19-negative and -positive groups, respectively; P=0.632), but some hours later, some were candidates for rescue percutaneous coronary intervention (PCI) due to cardiogenic shock (4 patients), persistent chest pain (5 patients) and non-acceptable ST resolution (3 patients).

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Table 1. Baseline characteristics of participation

Characteristics			Mean±SD		P*
			COVID-19 Negative (n=102)	COVID-19 Positive (n=29)	
Baseline characteristics	Gender	Male	84(82.35)	17(58.62)	0.007
		Female	18(17.65)	12(41.38)	
	Age (y)		58.19±10.97	63.97±12.54	0.039
	Body mass index (BMI) (kg/m^2)		26.9±4.72	25.68±2.24	0.257
Comorbid riskfactors	Dyslipidemia		17(16.66)	5(17.24)	0.942
	Hypertension		44(43.13)	16(55.17)	0.251
	Diabetes		26(25.49)	16(55.17)	0.003
	Insulin-dependent diabetes (IDDM)		5(4.90)	3(10.34)	0.280
	Chronic kidney disease (CKD)		3(2.94)	3(10.34)	0.092
	Peripheral artery disease (PAD)		1(0.98)	0	0.592
	Chronic obstructive pulmonary disease (COPD)		3(2.94)	1(3.44)	0.889
	History of coronary artery diseases (CAD)		17(16.66)	4(13.79)	0.710
	Previous myocardial infarction (MI)		4(3.92)	1(3.44)	0.907
	History of coronary artery bypass (CABG) surgery		2(1.96)	2(6.89)	0.173
	History of percutaneous coronary intervention (PCI)		13(12.74)	2(6.89)	0.383
	Heart failure (HF)		0	2(6.89)	0.008
	Prior cerebral vascular accidents (CVA)		3(2.94)	1(3.44)	0.889
	Smoking		47(46.07)	10(34.48)	0.266
Drug history	ASA		19(18.62)	4(13.79)	0.546
	Statin		14(13.72)	5(17.24)	0.635
	Clopidogrel		5(4.90)	2(6.89)	0.673
	Beta blockers		12(11.76)	2(6.89)	0.454
	ACEIs/ARBs		26(25.49)	9(31.03)	0.552

*The unpaired student t-test, Mann-Whitney U test, the chi-square test, and Fisher exact test based on the data.

Most patients were men in two groups of the study (82.35% and 58.62% of COVID-19-negative and -positive, respectively; P=0.007). Also, there was a statistically significant difference between the two groups regarding age, and COVID-19-positive patients were older (63.97±12.54 vs 58.19±10.97 years, P=0.039). Data are presented in Table 1.

The COVID-19-positive patients exhibited a higher prevalence of diabetes (P=0.003) and heart failure (P=0.008). Still, the two groups had no statistical differences for the other comorbid risk factors or drug history (Table 1).

Table 2 presents severe symptoms, echocardiographic and angiographic findings, and some laboratory data during admission. Erythrocyte sedimentation rate (ESR)

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Table 2. Clinical and laboratory data of patients during admission time

Variables			No. (%)/Mean±SD/Median (Q1, Q3)		P*
			COVID-19 Negative (n=102)	COVID-19 Positive (n=29)	
Severe symptoms	Pulmonary edema		0	0	-
	Cardiogenic shock		7(6.86)	3(10.34)	0.533
	Heart failure (HF)		0	0	-
	Atrial fibrillation (AF)		6(5.88)	2(6.89)	0.840
	Ischemic time (h)		2.50 (1.50, 4.50)	3 (1.75, 6.50)	0.489
Echocardiographic/ Angiographic findings	Ejection fraction (EF) (%)		40.83±11.35	36.61±10.98	0.065
	Pulmonary artery pressure (PAP) (mm Hg)		28.47±6.61	31.32±9.26	0.220
	Number of vessels diseases#	Single-vessel disease (SVD)	26(25.49)	4(13.8)	0.336
		Two-vessel disease (2VD)	31(30.40)	12(41.37)	
		Three-vessel disease (3VD)	45(44.11)	13(44.83)	
Laboratory data	White blood cell (WBC) (×10³/µL)		10.73±3.08	12.38±4.58	0.125
	Lymphocytes (%)		22.33±11.46	16.47±8.73	0.012
	Neutrophils (%)		71.43±12.41	77.35±9.16	0.018
	Erythrocyte sedimentation rate (ESR) (mm/ hour)		10 (5, 20)	28 (10, 41)	0.003
	Ferritin (ng/mL)		146.20 (115.20, 178)	163 (130.50, 323.20)	0.457
	C-reactive protein (CRP) (mg/dL)		8.40 (3.10, 25.70)	20.50 (7.50, 56.70)	0.096
	D-dimer (µg/L)		175(82,343)	404 (88,4630)	0.657
	Natriuretic peptide (NTproBNP) (ng/L)		527(206, 1483)	834.5 (157, 8365)	0.703
	Troponin, in admission (ng/L)		0.69 (0.12, 5.70)	1.59 (0.06, 11.38)	0.728
	Troponin, after six hours (ng/L)		21.49 (11, 35.04)	24.86 (9.42, 48.39)	0.415

*The unpaired student t-test, Mann-Whitney U test, chi-square test, and Fisher exact test based on the data.

#A vessel disease was defined as angiographic stenosis of more than 50%.

and neutrophil count were significantly higher in STEMI patients with COVID-19 infection (P=0.003 and P=0.018, respectively). Instead, lymphocyte count was significantly declined in COVID-19-infected patients (P=0.012).

Whereas STEMI patients with COVID-19 infection were more frequently subjected to coronary artery bypass graft (CABG) surgery during the first admission time (6.7% COVID-19-positive vs 1.96% COVID-19-negative), but this difference was not statistically significant (P=0.173). Furthermore, there were no statistical differences in other complications during hospitalization between the two groups of the present study (Table 3).

In addition, hospital length of stay (HLS) was statistically higher in the patients concomitant with COVID-19 infection (6.64±4.30 vs 4.93±3.59 days; P=0.023).

There were no statistically significant differences between the two groups regarding mortality rate during hospitalization (P=0.095) and 6 months after discharge

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Table 3. Clinical outcomes of participation

Complications during Hospitalization			
Variables	**No. (%)/Mean±SD/Median (Q1, Q3)**		**P[a]**
	COVID-19 Negative (n=102)	**COVID-19 Positive (n=29)**	
Stent thrombosis	1(0.98)	1(3.44)	0.339
Recurrent ischemia	3(2.94)	0	0.350
Recurrent myocardial infarction (MI)	1(0.98)	0	0.592
Coronary artery bypass (CABG) surgery during hospitalization	2(1.96)	2(6.7)	0.173
Gastrointestinal (GI) bleeding	1(0.98)	0	0.592
Retroperitoneal hematoma	2(1.96)	0	0.447
Complications During Follow-up Period (6 Months)			
Variables	**No. (%)/Mean±SD/Median (Q1, Q3)**		**P***
	COVID-19 Negative (n=97)	**COVID-19 Positive (n=25)**	
Re-angiography	8(8.24)	0	0.137
Re- percutaneous coronary intervention (PCI)	3(3.09)	1(4)	0.820
Late coronary artery bypass (CABG) surgery	2(2.06)	2(8)	0.137
Implantable cardioverter-defibrillator (ICD)	2(2.06)	2(8)	0.137
Gastrointestinal (GI) bleeding	0	0	-
Re-admission	17(17.52)	7(28)	0.240
Hospital Assessment			
Hospital length of stay (day)	4.93±3.59	6.64±4.30	0.023

*The unpaired student t-test, Mann-Whitney U test, chi-square test, and Fisher exact test based on the data.

(P=0.978). During the study period, the overall mortality rate in our setting was 8.82% and 17.24% in COVID-19-negative and -positive, respectively. There was also no statistically significant difference between the two groups (P=0.195). The results are reported in Table 4.

Table 4. Mortality outcomes

Mortality Outcomes	No. (%)		P*
	COVID-19 Negative (n=102)	COVID-19 Positive (n=29)	
During hospitalization	5(4.90)	4(13.79)	0.095
During six months	4(4.12)	1(4)	0.978
Overall mortality	9(8.82)	5(17.24)	0.195

*The chi-square test, Fisher exact test based on the data.

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Discussion

This study evaluated clinical characteristics and outcomes in STEMI patients comorbid with COVID-19 infection. We described our healthcare system's experience of patients presenting with STEMI during the first 6 months of the COVID-19 pandemic. Primary angioplasty is the best-recommended therapy for STEMI, and our setting is an academic center with 247 primary angioplasty and a success rate of more than 95% [8].

Cardiovascular diseases and underlying comorbidities have a high prevalence among COVID-19 patients. Increased risk and severity of COVID-19 infection were also proven in patients with comorbidities [1, 9, 10]. This finding accords with our observations, which showed that the comorbidities, including hyperlipidemia, hypertension, diabetes, chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), heart failure, and cerebral vascular accidents (CVA) were common in COVID-19 positive groups. However, only diabetes and heart failure were significantly more frequent in the STEMI patients with confirmed COVID-19.

Furthermore, prior studies have noted that many admitted patients with COVID-19 were men. Evidently, male gender and advanced age were independent risk factors for mortality in the COVID-19-positive population [11, 12]. Consistent with the noted literature, most patients in our study were men, and those infected patients with COVID-19 were older.

Inflammatory markers such as ESR, C-reactive protein (CRP), ferritin, and D-dimer have increased, but lymphocyte levels and neutrophilia are decreasing in COVID-19-infected patients [13]. In addition, Case et al. evaluated natriuretic peptide (NTproBNP) in acute myocardial infarction (AMI) patients with and without COVID-19 infection, which was increased in patients with COVID-19 [9]. In our setting, the patients with COVID-19 had higher levels of WBC, neutrophil, ESR, CRP, ferritin, D-dime, and NTproBNP. However, this study found no significant difference between inflammatory markers except ESR, lymphocyte, and neutrophil.

The present study did not show any significant increase in mortality rate among patients with concomitant COVID-19. This outcome is contrary to that of Case et al., who found a significantly increased mortality in AMI COVID-19-infected patients compared with AMI patients without COVID-19 [9].

The decline in the number of hospital admissions of patients with STEMI because of various reasons such as society's fear, lockdown, and allocation of high capacity of the hospital for COVID-19 patients during the early months of the pandemic contributed to the small sample size in our study. Therefore, the low sample size and the unequal number in the two study groups are possible reasons for these statistically non-significant different results between the two groups of our study.

This work was the first study about our healthcare system's experience, and we acknowledge the potential limitations of our research. Different variants of the COVID-19 virus and the availability of facilities and medications may have biased effects, as a confounding factor, on the study's results, especially mortality outcome. So, studies with larger populations are necessary.

Conclusion

Although the current study is based on a small sample of participants, the findings suggest differences in some parameters, especially underlying comorbidities between the STEMI patients with and without COVID-19 infection who were referred to our medical center during the first 6 months of the pandemic but there was no difference in mortality.

Ethical Considerations

Compliance with ethical guidelines

The protocol of the study was approved by the Institutional Review Boards of the Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.RETECH.REC.1399.671). The written informed consent was obtained from each patient before enrollment in the study.

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Authors' contributions

Study design: Roxana Sadeghi and Fatemeh Omidi; Investigation and drafting of the proposal, data interpretation, writing the original manuscript, review and editing: Roxana Sadeghi and Rezvan Hassanpour; Data collection: Fatemeh Omidi and Masoomeh Raoufi; Data analysis: Rezvan Hassanpour; Final approval: All authors.

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Conflict of interest

The authors declared no conflict of interest.

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