Effect of COVID-19 pandemic on management and the in-hospital outcome of ST segment elevation myocardial infarction

Bektas Murat, Selda Murat, Eylem Kivanc, Rafet Dizman

Original Article

Effect of COVID-19 pandemic on management and the in-hospital outcome of ST segment elevation myocardial infarction

Bektas Murat[1], Selda Murat[2], Eylem Kivanc[1], Rafet Dizman[1]

[1]Department of Cardiology, Eskisehir City TR Hospital, Eskisehir, Turkey
[2]Department of Cardiology, Eskisehir Osmangazi University, Medicine Faculty, Eskisehir, Turkey

Corresponding Author
Bektas Murat, MD
Department of Cardiology,
Eskisehir City Hospital,
Eskisehir
Turkey
E-mail: dr.bektash@hotmail.com
Phone (work): 00902226114000
(Cell phone): 00905074802729

ABSTRACT

Objective: The COVID-19 pandemic caused serious problems in the health system of the world resulting in delays in the management of ST segment elevation myocardial infarction (STEMI).

Design: Retrospective study

Setting: Department of Cardiology, Eskisehir City Hospital and Eskisehir Osmangazi University Faculty of Medicine

Subjects: 214 STEMI patients (Group 1-125 patients between 11/03/2019-31/05/2019; Group 2-89 patients between 11/03/2020-31/05/2020)

Interventions: Coronary angiography

Main outcome measures: To evaluate the effect of COVID-19 pandemic on the incidence, the clinical presentation and the in-hospital outcomes of acute STEMI

Results: There was a significant decrease in STEMI patients' admission during the COVID-19 period compared to that of previous year. It was found that patients in the group 2 presented significantly later than group 1. The longest delay was in the time from symptom-onset to the presentation to the hospital. The ejection fraction was significantly lower in Group 2 ($P<0.05$), and despite being statistically insignificant, cardiogenic shock was higher in Group 2.

Conclusion: With the onset of the COVID-19 pandemic, there was a decrease in the number of hospital admissions for acute STEMI patients and the most acute STEMI patients were shown to be complicated due to late admission to hospital. It is important that cardiologists have more knowledge about the indirect effects of such diseases on the cardiovascular system and organize their management protocol.

KEY WORDS: Corona virus-19, Acute ST segment elevated MI, Outcomes.

INTRODUCTION

Acute ST-elevation myocardial infarction (STEMI) is a complication of coronary artery disease that has the highest mortality and morbidity rate around the world, and percutaneous coronary intervention (PCI) is the proposed specific treatment [1,2]. The treatment strategies for STEMI have been developed to reduce the time from the symptom onset to the entrance to the catheterization laboratory to minimize myocardial damage. The time from the onset of chest pain to wire crossing is directly related to reduced mortality and morbidity in patients sustaining acute STEMI [3]. There are insufficient data regarding the effect of public emergencies related to disease outbreaks on the treatment practices of acute STEMI. The coronavirus disease (COVID-19), which originated from Wuhan, China, in December 2019 and spread throughout the world afterwards, hit Turkey on March 11, 2020. The patient care services of the hospitals have changed in many countries after the start of the pandemic. During this period, elective coronary angiography procedures and PCIs for stable coronary artery disease were all suspended in Turkey as in most countries to spare healthcare resources such as personal protective equipments (PPEs) and hospital beds for use in the care of patients with COVID-19. Although the American Heart Association and the Society for Cardiac Angiography and Interventions recommended continuing primary PCI in the treatment of acute STEMI during the COVID-19 pandemic, a significant decline has been reported in the rate of PCIs in the US as well as in

the world [4,5]. During this period, there have been changes in the number of patients presenting with acute STEMI, and the type and timing of presentation [6]. The present study aims to evaluate the effect of COVID-19 pandemic on the incidence, the clinical presentation, and the in-hospital outcomes of acute STEMI patients.

SUBJECTS AND METHODS

The patients, who presented to two pandemic hospitals (Eskisehir City Hospital and Eskisehir Osmangazi University Faculty of Medicine Hospital) serving as PCI centers with high patient loads (>100 PCIs/year) with the diagnosis of STEMI between March 11, 2020, and May 31, 2020, were included in this retrospective, observational study. These patients were compared with those who presented to the same centers during the same season in 2019. The patients with an unknown time of symptom onset, the patients who sustained STEMI in the hospital or cardiac arrest before admission to the hospital, and those without ST-segment elevation on the electrocardiogram (ECG) were excluded from the study. The patients' demographic data, laboratory results, data on STEMI management procedures, angiographic findings, and in-hospital outcomes were retrieved from the hospital records. STEMI was defined according to the Fourth Universal Definition of Myocardial Infarction [7]. The time from the symptom onset to the arrival at the emergency room was defined as the symptom onset-to-door time; the time from the arrival at the emergency room to the successful passage of the wire through the culprit coronary artery was defined as the door-to-wire time; the time from the arrival at the catheterization laboratory to wire crossing through the culprit coronary artery was defined as the Cath Lab to-wire time. A thrombus burden with the largest dimension measuring two times greater than the diameter of the vessel was defined as a large thrombus burden, and a thrombus burden with the largest dimension measuring less than two times of the vessel diameter was defined as a small thrombus burden [8,9]. The in-hospital outcomes included major bleeding, non-major bleeding, re-infarction, shock, and death. Re-infarction was defined as recurrent ST elevation ≥0.1 mV in at least two contagious leads on ECG together with ischemic symptoms lasting 20 minutes or longer or the occurrence of new pathognomonic Q waves and 20% or more increase in cardiac troponin levels [10]. Intracranial bleeding, cardiac tamponade, a Hb level less than 5 gr/dL despite the lack of an identifiable bleeding focus, and the death due to bleeding were defined as major bleeding events. Any bleeding was defined according to the Thrombolysis in Myocardial Infarction (TIMI) criteria [11]. The study protocol was approved by the Institutional Review Boards or Ethics Committees of the Eskisehir Osmangazi University (Approval number 20.05.2020/05).

Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD) and medians (Q1-Q3) categorical variables were defined as percentages. Kolmogorov-Smirnov test was used to investigate the suitability of the data for normal distribution. To compare continuous variables, we used Student's t test or Mann–Whitney U test, where appropriate. Categorical variables were compared via the chi-square and Fisher's Exact test. For all the tests, a value of $P<0.05$ was considered to be statistically significant. The

SPSS statistical software package (SPSS, version 15.0 for Windows; SPSS Inc., Chicago, IL) was used to perform all the statistical calculations.

RESULTS

In this retrospective study, the study sample was divided into two groups by taking into account the time variable in an attempt to evaluate the effect of coronavirus pandemic on the patients with STEMI. Group 1 (n=125, 58.4%) was composed of the patients who were admitted between March 11, 2019, and May 31, 2019 whereas Group 2 (n=89, 41.6%) was composed of the patients who were admitted between March 11, 2020, and May 31, 2020. When the number of the patients with STEMI who were admitted to the hospital in March, April and May is evaluated between 2019 (Group 1) and 2020 (Group 2), there was a significant decrease in the number of admitted patients in Group 2 in these three months (Figure 1). When the intergroup distribution of the study patients was evaluated, age, gender, smoking status, and history of hypertension and coronary artery disease (CAD) did not significantly differ between the groups. The number of patients with diabetes mellitus (DM) was significantly higher in Group 1 than that in Group 2 (p=0.008). Among the symptoms of myocardial infarction (MI), chest pain was more common in Group 1 (p=0.041) whereas the dyspnea was more common in Group 2 (p=0.023). The rate of cardiac arrest before hospital admission was similar in the two groups (Table 1). Regarding the angiographic findings, the number of the patients with high thrombus burden was significantly higher in Group 2 than that in Group 1 (p=.0.002) while the other angiographic findings did not significantly differ. When the laboratory results of the patients were evaluated Potassium (K^+), alanine aminotransferase (ALT), aspartate aminotransferase (AST), WBC (white blood count) high-sensitivity troponin (hsTrp), and creatine kinase-MB (CK-MB) were significantly higher in Group 2 than that in Group 1 ($P<0.05$). The table 2 shows numerically longer median times in all components of management time when compared with previous year. The longest time difference was in the time from symptom-onset to door. In terms of the in-hospital outcomes, the ejection fraction (EF) was significantly lower in Group 2 ($P<0.001$), and despite being statistically insignificant, the rate of cardiogenic shock was higher in Group 2 (Table 3).

DISCUSSION

The very first cases of COVID-19 in Turkey were spotted on March 11, 2020. There has been a change in the usual workflow of all the hospitals starting from the onset of coronavirus pandemic and a significant decline in the number of primary PCIs performed in our center for the patients with acute STEMI compared to the previous year although no change was made in our center in the treatment protocol. When the study months were taken into consideration, there was a significant decrease in the number of interventions during the COVID-19 pandemic when compared to the same seasonal period in the previous year (March, April, May 2020 vs. March, April, May 2019; 28.5%, 24.5%, and 35% decrease, respectively) (Figure 1). Consistent with the present findings, a similar decrease in the number of hospital admissions due to acute STEMI was noted in Hong Kong and the US [6,12]. However, previous studies have shown that environmental and psychosocial factors and viral outbreaks such as influenza infection increase hospital admissions due to acute STEMI [13]. Early diagnosis and treatment in myocardial infarction are known to be

directly related to mortality and morbidity. The reasons for a decrease in hospital admissions due to STEMI during COVID-19 pandemic could be due to the avoidance or reluctance of patients to seek medical support as part of the social distancing measures or to the fear of patients to contract coronavirus infection during such admissions. The most common presenting symptom in the present study during the period one year before the COVID-19 pandemic was typical angina pectoris ($p<0.05$) while the most common observed symptom during the COVID-19 pandemic was the dyspnea ($p<0.05$). Previous studies have reported a prolonged time between the symptom onset and the successful reperfusion in the patients with STEMI [6,14]. In our study, the most remarkable delay was observed in the time from the symptom onset to the arrival at the emergency room during the COVID-19 pandemic (Group 2) compared to the period before the pandemic (Group 1) ($p<0.05$). This delay may have multiple causes. One of the causes may be the avoidance of patients to seek medical support with the fear of contracting coronavirus until the symptoms become intolerable or general medical condition deteriorates. The present study also found a significant delay in the door-to-wire and Cath Lab arrival-to-wire times in the patients with STEMI ($p<0.05$). These delays were attributed to the time spent for body temperature measurement, recording travel and contact history, and the examination to identify the potential carriers of the infection and running radiological tests to rule out COVID-19. Also, catheterization and laboratory personal wearing personal protective equipment such as goggles, protective clothing and face masks after the patient was diagnosed with MI may cause an increase in time intervals. The delays in the diagnosis and treatment can cause complications such as in-hospital cardiogenic shock and heart failure. In a study by Tam et al, no statistically significant difference was observed in terms of in-hospital outcomes [14] while the EF before discharge was significantly lower in Group 2 ($p<0.05$), despite not being statistically significant, the rate of cardiogenic shock was higher in Group 2 ($p=0.07$). The results of the present study suggest a decrease in the number of patients with STEMI during the COVID-19 pandemic; however, these results are not sufficient to suggest if the decrease in the number of the patients with STEMI is caused by the avoidance of patients to attend hospital or the death of the majority of the patients at home or decreased likelihood of sustaining MI during the quarantine period as the patients remain immobile and stress-free at their homes. The most important limitation of the study is that, due to the retrospective study design, no face-to-face interview has been made to enquire the reasons for not attending the hospital in detail. There is a need for large-scale multicenter studies to search for a clear answer to these questions.

CONCLUSION

With the onset of the COVID-19 pandemic, there was a decrease in the number of hospital admissions for acute STEMI patients and the most acute STEMI patients were shown to be complicated due to late admission to hospital. It is important that cardiologists have more knowledge about the indirect effects of such diseases on the cardiovascular system and organize their management protocol. And at the same time, hospitals and the health care systems need to be well prepared for STEMI care and treatment.

ACKNOWLEDGMENTS

This study is the authors' own study and did not receive any grant or funding.

Conflicts of interest: The authors declare no conflict of interest

Authors Contribution: BM: Conception design, methodology, manuscript writing, SM: Data searching, data extracting, EK: literature search, data extraction and recording, manuscript writing and tables and figure preparation. RD: Data curation, language editing. Formal analysese

REFERENCES

1. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-D C, Bueno H *et al*. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J 2018;39:119-177.
2. O'Gara PT, Kushner FG, Ascheim DD, Casey Jr DE, Chung MK, Lemose J *et al*. American College of Cardiology Foundation/American Heart Association Task Force on Practice G. 2013 accf/aha guideline for the management of st-elevation myocardial infarction: A report of the american college of cardiology foundation/american heart association task force on practice guidelines. Circulation 2013;127: e362-e425.
3. Miller AC, Ward MM, Ullrich F, Merchant KAS, Swanson MB, Mohr NM. Emergency Department Telemedicine Consults are Associated with Faster Time-to-Electrocardiogram and Time-to-Fibrinolysis for Myocardial Infarction Patients. Telemed J E Health 2020;10
4. Welt FGP, Shah PB, Aronow HD, Bortnick AE, Henry TD, Sherwood MW *et al*. Catheterization Laboratory Considerations During the Coronavirus (COVID-19) Pandemic: From the ACC's Interventional Council and SCAI. (Editorial)J Am Coll Cardiol 2020;75(18):2372-2375.
5. Rodríguez-Leor O, Cid-Álvarez B, Ojeda S, Moreiras J M, Rumoroso FJR, López-Palop GR *et al*. Impact of the COVID-19 pandemic on interventional cardiology activity in Spain. REC Interv Cardiol 2020;2(2):82-89.
6. Tam CF, Cheung KS, Lam S, Wong A, Yung A, Szeet M *et al*. Impact of Coronavirus Disease 2019 (COVID-19) Outbreak on ST-Segment-Elevation Myocardial Infarction Care in Hong Kong, China. (Reasearch letter) Circ Cardiovasc Qual Outcomes. 2020;13:e006631.
7. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA *et al*. Fourth Universal Definition of Myocardial Infarction (2018). Glob Heart. 2018;13:305-338.
8. Gibson CM, de Lemos JA, Murphy SA, Marble SJ, McCabe CH, Cannon CP, *et al*. Combination therapy with abciximab reduces angiographically evident thrombus in acute myocardial infarction: a TIMI 14 substudy. Circulation 2001;103:2550-2554.
9. Vautrin E, Jean ABP, Fourny M, Marlière S, Vanzetto G, Bouvaist H *et al*. Sex differences in coronary artery lesions and in-hospital outcomes for patients with ST-segment elevation myocardial infarction under the age of 45. Catheter Cardiovasc Interv. 2019;10.1002/ccd.28627.

10. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD, Writing Group on the Joint ESC/ACC/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction. Third universal definition of myocardial infarction. Eur Heart J. 2012; 33:2551–67.
11. Bovill EG, Terrin ML, Stump DC, Berke AD, Frederick M, Collenet D *et al*. Hemorrhagic events during therapy with recombinant tissue-type plasminogen activator, heparin, and aspirin for acute myocardial infarction. Results of the Thrombolysis in Myocardial Infarction (TIMI), Phase II Trial. Ann Intern Med 1991;115:256-265.
12. Garcia S, Albaghdadi MS, Meraj PM, Schmidt C, Garberich R, Jafferet FA *et al*. Reduction in ST-Segment Elevation Cardiac Catheterization Laboratory Activations in the United States During COVID-19 Pandemic. J Am Coll Cardiol 2020;75:2871-2872.
13. Kwong JC, Schwartz KL, Campitelli MA, Chung H, Crowcroft NS, Karnauchow T *et al*. Acute Myocardial Infarction after Laboratory-Confirmed Influenza Infection. N Engl J Med 2018;378:345-353.
14. Tam CF, Cheung KS, Lam S, Wong A, Yung A, Sze M *et al*. Impact of coronavirus disease 2019 (COVID-19) outbreak on outcome of myocardial infarction in Hong Kong, China. Catheter Cardiovasc Interv 2020;10.

Table 1: Demographic information and angiographic findings of patients

Parameters	**Group 1 March/11/2019-May/31/2019 (82 days)**	**Group 2 March/11/2020-May/31/2020 (82 days)**	***P*-value**
Patients	N=125	N=89	
Age ± SD	61.30±11.46	59.48±11.26	0.252
Gender			0.656
Male(%)	98 (78.4%)	72 (80.9%)	
Female(%)	27 (21.6%)	17 (19.1%)	
Smoker(%)	69 (55.2%)	47 (52.8%)	0.729
Diabetes Mellitus(%)	56 (44.8%)	24 (27.0%)	**0.008**
Hypertension(%)	52 (41.6%)	27 (30.3%)	0.092
Previous CAD(%)	30 (24.0%)	23 (25.8%)	0.758
Typical Angina(%)	110 (88.0%)	69 (77.5%)	**0.041**
Dyspnea(%)	18 (14.4%)	24 (27.0%)	**0.023**
Pre-hospital death(%)	4 (3.2%)	3(3.4%)	>0.999
Type of STEMI			0.712
Anterior MI(%)	50 (40.0%)	45 (50.6%)	
Anterolateral MI(%)	1 (0.8%)	1 (1.1%)	
İnferior MI(%)	62 (49.6%)	37 (41.6%)	
Posterior MI(%)	5 (4.0%)	4 (4.5%)	
Lateral MI(%)	3 (2.4%)	1 (1.1%)	
Inferolateral MI(%)	3 (2.4%)	1 (1.1%)	
Vessel involvement			0.484
1 Vessel (%)	97 (77.6%)	66 (74.2%)	
2 Vessel (%)	20 (16.0%)	14 (15.7%)	
3 Vessel (%)	8 (6.4%)	9 (10.1%)	
Thrombus burden (%)			**0.002**
No thrombus	116 (92.8%)	69 (77.5%)	

Low thrombus burden < 2 diam	2 (1.6%)	11 (12.4%)	
High thrombus burden > 2 diam	7 (5.6%)	9 (10.1%)	
Culprit coronary			
LMCA(%)	2 (1.6%)	1 (1.1%)	>0.999
LAD(%)	40 (32.0%)	34 (38.2%)	0.347
CX(%)	18 (14.4%)	9 (10.1%)	0.352
RCA(%)	37 (29.6%)	20 (22.5%)	0.245
The others(%)	26 (20.8%)	24 (27.0%)	0.293
Laboratory results 1	**Median (Q1-Q3)/ Mean±SD**	**Median (Q1-Q3)/ Mean±SD**	
Platelet (10^3/µL)	232.0 (190.5-293.0)	266.0 (215.5-298.0)	0.034
Potassium(mmol/L)	4.10 (3.80-4.48)	4.57 (4.10-4.94)	**<0.001**
ALT (u/L)	29.0 (18.0-89.0)	73.0 (31.0-137.5)	**<0.001**
AST (u/L)	36.0 (20.0-151.5	160.0 (70.5-274.0)	**<0.001**
Hs Trp (pg/ml)	324.7 (53.2-2561.0)	1653.0 (115.1-15766.0)	**0.001**
CKMB(ng/mL)	6.09 (2.10-34.80)	21.00 (2.64-79.50)	**0.027**
Laboratory results 2			
Hemoglobin (g/dL)	14.60(12.95-16.30)	15.30(13.70-16.25)	0.183
Wbc (10^3/µL)	11.30(9.29-13.50)	12.20(10.24-14.10)	**0.024**
Hematocrit (%)*	42.92±5.60	43.43±5.56	0.510
Neutrophil (10^3/µL)	7.08(5.20-10.11)	7.97(5.91-10.52)	0.099
Lymphocyte (10^3/µL)	2.34(1.54-3.55)	2.16(1.43-3.82)	0.873
Sodium (mmol/L)	137(135-139)	137(134-139)	0.694
Glucose (mg/dL)	138(114-210)	140(110.5-206)	0.971
Bun (mg/dL)	16.20(12.90-20.50)	14.90(12.4-18.95)	0.194
Creatinin (mg/dL)	0.92(0.80-1.12)	0.92(0.79-1.07)	0.811
Given treatment at first 24 hours			

ASA(%)	125 (100%)	89 (100%)	
Statin(%)	124 (99.2%),	87 (97.8%)	0.573
Beta-blockers (%)	83 (66.4%)	64 (71.9%)	0.490
ACEIs/ARBs (%)	78 (62.4%)	50 (56.2%)	0.360
P2Y12 inhibitors(%)	125 (100%)	89 (100%)	
LMWH(%)	125 (100%)	89 (100%)	
Glycoprotein IIb/IIIa inhibitors(%)	8 (6.4%)	10 (11.2%)	0.209

ACEIs: angiotensin-converting enzyme inhibitors; ARBs: angiotensin receptor blockers; ALT: alanine transaminase; ASA: acetylsalicylic acid; AST: aspartate aminotransferase; CK-MB: creatine kinase MB; CX: circumflex artery; Hs Trp: high sensitive troponin; LAD: left anterior desceding artery; LMCA: left main coronary artery; LMWH: low molecular weight heparin; RCA: right coronary artery; STEMI: ST segment elevation myocardial infarction

Table 2: Duration in STEMI management (By minutes)

Duraiton of patients' management	**Group 1 March/11/2019-May/31/2019 (82 days)**	**Group 2 March/11/2020-May/31/2020 (82 days)**	***P*-value**
	Median (Q1-Q3)	**Median (Q1-Q3)**	
Symptom-onset to door	88.0(60.0-119.0)	177.0(120.0-355.0)	**<0.001**
Door to cath lab.	32.0(22.50-44.50)	40.0(29.5-62.5)	**<0.001**
Cath lab to wire	17.00(13.0-20.50)	20(18.5-30.0)	**<0.001**
Door to wire	50.0(40.0-63.0)	69.0(50.0-87.00)	**<0.001**
Total ischemic time	140.0(110.50-170.0)	240.0(175.0-453.0)	**<0.001**

Table 3: Patients in-hospital outcomes

Outcome parameters	**Group 1 March/11/2019-May/31/2019 (82 days)**	**Group 2 March/11/2020-May/31/2020 (82 days)**	***P*-value**
EF before discharge	**Median (Q1-Q3)** 56(45.50-60.0)	**Median (Q1-Q3)** 50(42.50-56.0)	**<0.001**
Reinfarction	2(%1.6)	2(%2.2)	>0.999
Major bleeding	3 (%2.4)	1 (%1.1)	0.643
Minor bleeding	2 (%1.6)	2 (%2.2)	>0.999
Cardiojenic shock	6 (%4.8)	10 (%11.2)	0.078
Death	6 (%4.8)	5 (%5.6)	>0.999

EF: Ejection fraction

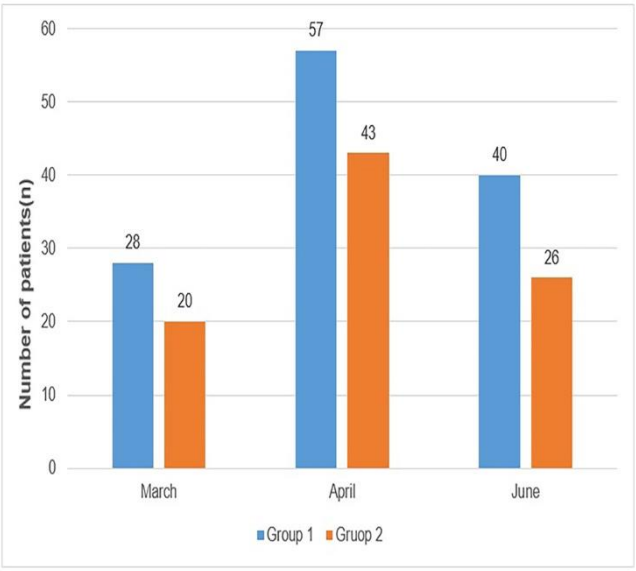

Figure1: Decline of STEMI patients' admission during COVID-19 pandemic by months