

Effects of the COVID-19 pandemic on the emergency management of patients presenting with ST-elevation myocardial infarction

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ABSTRACT

Objectives: This study aims to analyze the changes in the emergency management of ST-elevation myocardial infarction (STEMI) patients during the coronavirus disease 2019 (COVID-19) pandemic.

Patients and methods: A total of 474 individuals (375 males, 99 females; mean age: 61.7±12.7 years; range, 22 to 93 years) who presented to the emergency department with STEMI between March 1, 2019, and March 1, 2021, were included in the study. The impact of the pandemic on the management of STEMI patients was assessed by comparing the patients in two time periods: the pre-COVID-19 period (n=271) and the COVID-19 pandemic (n=203). Archive records were retrospectively examined to assess the pandemic's impact on various aspects, including arrival time at the emergency department, consultation duration, time from arrival to percutaneous coronary intervention, treatment choice, in-hospital mortality rate, and length of inpatient stay.

Results: There was a notable decrease in the proportion of patients arriving within 2 h of symptom onset during the COVID-19 era ($p<0.05$). The mean time for STEMI patients to be referred to the cardiology clinic was 15.90±21.97 min. Additionally, the door-to-needle time was faster during the COVID-19 era compared to the prepandemic period.

Conclusion: Despite the prolonged duration of presentation to the emergency department for patients exhibiting symptoms of STEMI during the COVID-19 era, there was no extension in the consultation and door-to-needle times for patients diagnosed with STEMI.

Keywords: Acute coronary syndromes, myocardial revascularization, pandemic percutaneous coronary intervention.

Cardiovascular diseases are a prevalent cause of mortality worldwide. In the year 2022, approximately 35.4% of deaths were attributed to disorders of the circulatory system. This global burden affects a significant population of 18 million individuals. The primary cause of mortality in relation to cardiovascular diseases is coronary artery disease, specifically characterized by the accumulation of atherosclerotic plaques in the coronary arteries over time.^[1] While this condition may remain stable for an extended duration, it can transition into an unstable state as a consequence of atherothrombotic events following plaque rupture.^[2] Numerous risk factors contribute to the development of coronary artery disease, including smoking, diabetes, hyperlipidemia, hypertension, male gender, a family history of the condition, and obesity.^[3] Managing these risk factors is imperative in the prevention of coronary artery disease and in enhancing the efficacy of applied therapeutic interventions.^[4]

Acute myocardial infarction occurs due to acute myocardial ischemia, resulting in the necrosis of cardiomyocytes.^[5] A clinical manifestation of acute myocardial infarction is ST-elevation myocardial infarction (STEMI), characterized by the presence of ST-segment elevation on the electrocardiogram and symptoms indicative of myocardial ischemia. It arises from the complete occlusion of the coronary artery and necessitates immediate medical attention.^[6] Failure to promptly restore blood flow to the affected area leads to transmural

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necrosis. The extent of necrosis is influenced by the duration of revascularization, with prolonged intervals resulting in the expansion of the necrotic region and reduced salvage of myocardial tissue.^[7] The prognosis of STEMI is closely associated with the salvaged myocardial area. Two interventions are employed to achieve revascularization in patients with STEMI: primary percutaneous coronary intervention (PCI) and thrombolytic therapy. Primary PCI is the recommended first-line treatment for individuals experiencing STEMI.^[8]

The coronavirus disease 2019 (COVID-19) pandemic has had a profound impact on healthcare services, with enduring consequences. Originating in Wuhan, China, in December 2019, the World Health Organization (WHO) declared it a pandemic on March 11, 2020. As of October 4, 2023, the WHO has reported a total of 771,151,224 confirmed cases of COVID-19, resulting in 6,960,783 deaths. The pandemic necessitated the allocation of a significant portion of healthcare resources to the management of COVID-19 patients. Consequently, the emergency management of various diseases, including STEMI, underwent modifications. Many countries implemented quarantine measures and social distancing protocols, leading to the postponement of elective procedures in hospitals. In conjunction with the public's fear of contracting COVID-19, this resulted in a substantial decrease in non-COVID-19-related patient admissions, including those with STEMI. Consequently, the time interval between the onset of symptoms and treatment for STEMI patients increased, accompanied by a reduction in the number of primary PCIs performed. The extended delay in treatment initiation has subsequently contributed to elevated mortality rates.^[9] During the COVID-19 era, it was found that STEMI patients who tested positive for COVID-19 had a higher mortality rate and were more likely to be hospitalized for heart failure during long-term follow-up.^[10] This study aimed to analyze the changes in the emergency management of STEMI patients during the pandemic.

PATIENTS AND METHODS

The single-center retrospective observational study was conducted with 474 patients. Records of patients who sought medical attention at the emergency department of the Dokuz Eylül University Hospital between March 1, 2019, and March 1, 2021,

were examined. The inclusion criteria for the study were patients who were diagnosed with STEMI. Conversely, individuals who exhibited another medical condition leading to ST-segment elevation, encountered difficulties in accessing angiography notes, or had incomplete archive records were excluded from the study. Consequently, a total of 474 patients (375 males, 99 females; mean age: 61.7±12.7 years; range, 22 to 93 years) were included in this study, while a subset of 23 patients who fulfilled at least one of the exclusion criteria were not incorporated in the analysis. The patients were assessed in two distinct time periods to assess the changes in the emergency management of STEMI patients during and before the pandemic: the pre-COVID-19 period (2019-2020), which included 271 patients, and the COVID-19 pandemic (2020-2021), which included 203 patients.

The data pertaining to patients who fulfilled the specified criteria was duly documented in accordance with the prescribed data form of the study. The data was gathered from the hospital's information management system and the record archives of the Department of Cardiology and the Department of Emergency Medicine. The study involved scanning archive records for sex, age, demographic characteristics, vital signs, admission times, symptom durations, arrival options to the hospital, accompanying diseases, risk factors, electrocardiogram findings, diagnosis and consultation durations, treatment decisions, treatment outcomes, in-hospital mortality, and length of hospitalization.

The treatment decisions were classified as follows: patients who underwent coronary angiography (CAG) within the initial 2-h period were designated as very urgent CAG. Individuals who underwent CAG between 2 to 8 h were classified as urgent CAG. Those who solely received thrombolytic treatment without undergoing CAG were categorized separately. The duration between the patient's arrival at the emergency department and their subsequent undergoing of CAG was defined as door-to-needle time. To evaluate the impact of the pandemic on the duration between symptom onset and emergency department presentation, we analyzed arrival times and classified them into four subcategories: <2 h, 2 to 6 h, 6 to 12 h, and >12 h. Furthermore, the patients' arrival times were categorized based on whether they occurred during regular working hours (08:00-17:00) or outside of these hours (17:00-08:00).

Statistical analysis

The data underwent statistical analysis utilizing the IBM SPSS version 24.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistical analyses were executed for all data, with the determination of their frequencies. Comparative statistical analyses, in accordance with the hypothesis, were conducted utilizing the independent sample t-test and Pearson's chi-square test, contingent upon the type of variable. The variables were derived from patient information extracted from the data form. A p -value <0.05 was considered statistically significant.

RESULTS

A statistically significant association was observed between sex and the occurrence of STEMI ($p=0.002$). Moreover, the study assessed the impact of working hours on patient arrival times, distinguishing between daytime (08:00-17:00) and nighttime (17:00-08:00). Out of the total patient

population, 167 (35.2%) individuals arrived during the day, whereas 307 (64.8%) patients presented during the night. However, the analysis did not reveal a statistically significant difference in admission times ($p=0.053$). The investigation also compared the duration of symptoms between the pre-COVID-19 and COVID-19 periods, stratifying the intervals into 0-2 h, 2-6 h, 6-12 h, and >12 hours. In the pre-COVID-19 era, the majority of 139 (51.3%) patients sought medical assistance within the 0-2 h time frame. Conversely, during the COVID-19 period, only 68 (33.5%) individuals presented within the same time frame. Notably, a statistically significant difference was observed between these two groups ($p=0.002$) (Table 1).

After receiving the diagnosis, the mean duration for cardiology consultation in the entire patient population amounted to 15.90 ± 21.97 min. Within the pre-COVID-19 and COVID-19 eras, the minimal duration was 3 min, whereas the maximal duration reached 26 min. There existed no statistically

Table 1
Comparison of all patients according to the pre-COVID-19 and COVID-19 periods (n=474)

Variables	Pre-COVID-19 period (n=271)				COVID-19 period (n=203)				p
	n	%	Mean±SD	Min-Max	n	%	Mean±SD	Min-Max	
Age (year)			61.0±12.6	22-93			62.6±12.9	31-93	
Sex									0.219
Male	211	77.8			164	80.7			
Female	60	22.1			39	19.2			
Appointment time									0.523
08:00-17:00	92	33.9			75	36.9			
17:00-08:00	179	66.1			128	63.1			
Comorbidity and risk factors									
Hypertension	153	56.5			115	56.6			0.798
Diabetes mellitus	89	32.8			74	36.5			0.414
Coronary artery disease	75	27.7			59	29.1			0.740
Hyperlipidemia	17	6.3			2	1			0.005*
Smoking	113	41.7			140	69.3			0.005*
COVID-19 history	0	0			0	0			0
Family history	12	4.4			14	6.9			0.244
Mode of arrival									
Walk-in	110	40.6			85	41.8			
Ambulance	161	59.4			118	58.2			
Arrival time (hour)									
<2	139	51.3			68	33.5			0.002*
2-6	64	23.6			66	32.5			0.294
6-12	9	3.3			10	4.9			0.426
>12	59	21.8			59	29.1			0.305

SD: Standard deviation; * Statistically significant.

Table 2
The treatment duration, door-to-needle time, and mortality comparison between the periods

Variables	Pre-COVID-19 period (n=271)		COVID-19 period (n=203)		p
	n	%	n	%	
Treatment					0.005*
Very urgent CAG (first 2 h)	238	87.8	194	95.6	
Urgent CAG (2-8 h)	29	10.7	8	3.9	
Thrombolytic	4	1.5	1	0.5	
Door-to-needle time (min)	45		37		0.183
Hospital mortality					0.997
Yes	24	8.8	18	8.8	
No	247	91.2	185	91.2	

CAG: Coronary angiography.

significant disparity in the duration of cardiology consultation subsequent to diagnosis ($p=0.855$).

The treatments administered to patients with STEMI encompassed very urgent CAG (within a span of 2 h), urgent CAG (spanning from 2 to 8 h), and the application of thrombolytic agents. Out of a total of 474 patients, 432 (91.1%) underwent very urgent CAG, 37 (7.8%) underwent urgent CAG, and a decision concerning thrombolytic therapy was made in five (1.1%) instances.

Upon scrutinizing the treatments administered in the pre-COVID-19 and COVID-19 periods, the frequency of very urgent CAG escalated from 87.8 to 95.6%, whereas urgent CAG experienced a decline from 10.7 to 3.9%. The decision for thrombolytic therapy dwindled from 1.5 to 0.5%. A greater number of very urgent CAG procedures were executed during the COVID-19 period. Patients were admitted to CAG more promptly during the COVID-19 period. A statistical significance was detected between the two periods ($p<0.05$).

In the pre-COVID-19 period, the mean door-to-needle time was 51.61 ± 35.32 min. In the COVID-19 period, it was reduced to 49.09 ± 46.59 min.

Within the pre-COVID-19 period, 24 (8.8%) out of 271 patients succumbed. During the COVID-19 period, this figure was 18 (8.8%). No statistically significant disparity was discerned in the evaluation ($p=0.997$) (Table 2).

When analyzing the duration of hospital stays for patients, specifically comparing the pre-COVID-19 and COVID-19 periods, it was found that the mean duration for the pre-COVID-19 period was 5.45 ± 4.026 days. The shortest stay recorded in this period was one day, while the longest stay lasted for 28 days. The mean duration for the COVID-19 period was 5.29 ± 3.807 days, with a minimum stay of one day and a maximum stay of 32 days. The median durations for both periods were found to be 4 days. Upon comparing the two periods, no statistically significant difference was observed ($p=0.655$) (Table 3).

DISCUSSION

With the declaration of COVID-19 as a global pandemic, states initially opted to cancel all elective procedures and place emphasis on the importance of staying at home for patients and their families. These measures resulted in a notable reduction in the number of non-COVID-19-related complaints presented to the emergency department. European countries have observed a significant decrease in the incidence of STEMI cases since the onset of

Table 3
Comparison of patient discharges between the pre-COVID-19 and COVID-19 periods

Discharge time	Mean±SD	Min-Max
Pre-COVID-19	5.45±4.026	1-28
COVID-19	5.29±3.807	1-32

COVID-19: Coronavirus disease 2019; SD: Standard deviation.

the pandemic, prompting inquiry into the potential factors contributing to this change. A study conducted by the Spanish Society of Cardiology, along with similar findings in Hong Kong, reported a decline of up to 40% in PCI procedures for STEMI.^[11]

Our study aimed to examine whether there were any disparities in the emergency management of STEMI patients between the pre-COVID-19 and COVID-19 periods. In our investigation, we found no statistically significant differences in the age and sex distributions of patients who sought care at the emergency department during both the pre-COVID-19 and COVID-19 periods. Similarly, Ayad et al.^[12] conducted a study that revealed no significant distinctions in the age and sex of patients between the two periods.

When comparing the timing of STEMI patients' presentations at the emergency department in the pre-COVID-19 and COVID-19 periods, it was observed that during the pre-COVID-19 period, 139 patients arrived within a time frame of less than 2 h, whereas in the COVID-19 period, only 68 patients arrived within the same time frame. Notably, STEMI patients exhibited a significant delay in seeking care at the emergency department during the COVID-19 period. Hammad et al.'s^[13] study reported that during the COVID-19 period, 35 patients with STEMI presented themselves 12 h after experiencing symptoms. Furthermore, 27% of these patients refrained from seeking care due to fear of COVID-19, 18% attributed their symptoms to COVID-19, and 9% wished to avoid burdening the emergency department amidst the pandemic. Given the retrospective nature of our study, we were unable to explore the specific reasons for these delays in presentation. However, it is plausible that concerns surrounding infection, movement restrictions, and the desire to minimize the strain on hospitals may have contributed to this situation.^[14]

In our investigation, the mean duration from the moment the patient manifested symptoms of STEMI to the time of admission for CAG was found to be 51.61 ± 35.32 min during the pre-COVID-19 era. However, in the COVID-19 era, this time frame was reduced to 49.09 ± 46.59 min. Existing literature has shown that the period for patient admission for CAG has increased during the COVID-19 era compared to the pre-COVID-19 era, as stated in

numerous studies.^[12,13,15,16] In our research, although no statistically significant outcome was obtained, it was observed that CAG procedures were carried out more expeditiously within our hospital during the COVID-19 era. During this time, patients presenting with STEMI symptoms were admitted for CAG without waiting for polymerase chain reaction (PCR) test results, assuming that each patient had COVID-19. They were then examined and treated according to the latest guidelines. All healthcare professionals in our hospital quickly evaluated the patients while ensuring their own personal safety measures. In our hospital, patients with STEMI who required emergency CAG were taken to the angiography room without waiting for PCR results. In addition, as in the whole world, the number of patients presenting to our hospital during the COVID-19 period decreased compared to the pre-COVID-19 period.^[15,16] It was thought that the decrease in the number of presenting patients and the resulting decrease in the workload on healthcare professionals contributed to the shortening of the admission time for CAG during the COVID-19 period.

In our study, the mean time for STEMI patients to be consulted with cardiology after receiving a diagnosis was 15.90 ± 21.97 min. In the study conducted by Duygu^[17] in our hospital in 2012, this duration was reported to be an median of 17 min. The relatively shorter consultation times for patients diagnosed with STEMI in our hospital indicate an improvement in the diagnosis process. In our hospital, using current guidelines for the diagnosis and treatment of patients presenting with chest pain and the healthcare personnel's dedication to ensuring personal safety throughout the diagnosis and treatment process were considered significant factors in shortening the diagnosis process. In our study, when treatment decisions were evaluated, statistically significant differences were found in the pre-COVID-19 and COVID-19 periods. In the COVID-19 period, it was thought that not waiting for PCR results by assuming that patients were infected with COVID-19 and taking personal safety measures increased the rate of emergency PCI due to the decrease in the number of patients presenting to the emergency department. Studies recommending delaying CAG or using thrombolytic therapy until the infection status with COVID-19 becomes clear exist in the literature.^[18,19] However, in our hospital,

the gold standard treatment for STEMI, which is CAG, was continued to be applied without delay.

In the study conducted by Xiang et al.^[14] an increase in mortality was observed during the pandemic period. However, in our study, it was observed that the mortality rates did not change in the pre-COVID-19 and COVID-19 periods. It was thought that the implementation of a standardized diagnosis and treatment process in line with current guidelines and not delaying the CAG procedure were the main reasons for the nonincrease in mortality in our hospital.

The relatively low number of patients in our study, insufficient patient admissions during the COVID-19 pandemic, inability to reach a sufficient number of COVID-19-positive STEMI patients, short-term follow-up of patients, and obtaining patient information from records are important limitations to this study.

In conclusion, a decrease was observed in the number of patients diagnosed with STEMI and the number of admissions within the critical first 2 h after symptom onset due to concerns related to the COVID-19 pandemic. The time taken for patients to be referred to cardiology after being diagnosed with STEMI at our center was not affected by seasonal changes. The door-to-needle time was accomplished in a shorter period during the COVID-19 pandemic. Patients at our center were admitted to the catheterization laboratory at the same speed, regardless of whether it was before or during the pandemic. As a result, this study did not observe any adverse effects of the pandemic period on the emergency management of patients diagnosed with STEMI.

Ethics Committee Approval: The study protocol was approved by the Dokuz Eylül University Faculty of Medicine Ethics Committee (date: 22.02.2021, no: 2021/06-03). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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