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Research Article

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CONFRONTING THE DUAL CHALLENGE: THE IMPACT OF THE COVID-19 PANDEMIC ON THE MANAGEMENT OF ACUTE CORONARY SYNDROMES IN A LEADING TERTIARY HOSPITAL IN TURKEY

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Abstract

Objectives: In this study, we aimed to determine the impact of the SARS-CoV-2 pandemic (COVID-19) on the number, morbidity and mortality of acute myocardial infarction patients in Ankara Bilkent City Hospital, which has the largest patient capacity in the European region.

Materials and Methods: A total of 1173 patients who were hospitalized with the diagnosis of acute myocardial infarction in Ankara Bilkent City Hospital between December 2019 to July 2020 were included in this study. These patients were divided into two groups according to the admission date. In this study, in light of the measures taken with the onset of the COVID-19 pandemic in Turkey, the effect of the pandemic on hospital admissions, application types, number of patients, laboratory, echocardiography, and angiography parameters of patients diagnosed with acute myocardial infarction (AMI) was investigated.

Results: The month with the highest number of patients admitted to the emergency department was December, and the month with the lowest number was April. Compared to pre-COVID-19, an approximately 19% decrease was observed in hospital admissions after COVID-19. Also, medical treatment was more common than revascularization after the pandemic (73.43% vs. 26.56%, respectively, $p < 0.001$). The frequency of non-culprit lesion intervention was significantly decreased after the COVID-19 pandemic compared to the time before the pandemic. (39.24% vs 60.75%, respectively, $p = 0.002$).

Conclusion: Coronavirus-19 pandemic reduced not only the admission of AMI patients to hospitals but also the frequency of revascularization and intervention in the non-culprit artery before discharge. All of these factors led to low ejection fraction and high troponin values in these patients.

Keywords: Acute myocardial infarction, covid-19 infection, pandemic, curfew, revascularization.

Introduction

The lack of effective and reliable treatment at the beginning of the COVID-19 pandemic caused a major crisis in the healthcare system. The increase in hospital admissions due to COVID-19 disease, coupled with the lack of effective treatment, resulted in almost all intensive care units being filled, thereby interrupting the treatment of other diseases.[1] As in many countries, practices such as curfew, reduced hospital admissions except in emergencies, and the postponement of elective procedures were implemented in Turkey. [2,3] The aim of this study is to investigate the modifications in the management of patients who presented with acute coronary syndrome to our tertiary care hospital during the pandemic period, in comparison to the pre-pandemic era. Specifically, the study seeks to analyze any changes in diagnostic, therapeutic and overall care procedures employed for this patient population and to identify the reasons behind such changes. By doing so, this research aims to shed light on the impact of the pandemic on healthcare delivery and contribute to the existing literature on acute coronary syndrome management during crisis situations.

Materials and Methods

The first case of the COVID-19 pandemic detected by the Ministry of Health in Turkey was on March 11, 2020.[4] In this study, the data of patients diagnosed with AMI as specified in the ICD code between December 1, 2019, and March 10, 2020, at Ankara Bilkent City Hospital were compared with patients diagnosed with the same code between March 11, 2020, and July 31, 2020, in the hospital data reporting system. Demographic data obtained from the system, mortality rates, length of hospital stay, whether revascularization was performed, the time of percutaneous interventions, the medical treatments, the comparison of thrombus load in terms of coronary artery disease during the procedure, mainly left ventricular ejection fraction (LVEF) levels in echocardiography performed at discharge were investigated in terms of how the pandemic affected the number of patients, mortality and morbidity. Hemogram (Symex K-1000, Kobe, Japan) and biochemistry parameters (Roche Diagnostic Modular Systems, Tokyo, Japan) for laboratory values were studied in the central biochemistry laboratory of our hospital. Echocardiographic examinations of the patients were evaluated by specialist cardiologist physicians in our hospital using the Philips Affiniti 50C, Release 3.0.3, 3000 Minuteman Road, Andover, MA 01810 USA model device. Imaging and evaluation were performed by specialist interventional cardiologists in our hospital with General Electric (GE) INNOVA IGS 620, Rye de la Miniere, France, and GE OPTIMA IGS 320 001, Milwaukee, Wisconsin, model devices used in the catheter laboratory in patients undergoing coronary angiography both during the working hours and the night shifts.

Statistical analysis

The Mann-Whitney U test was used to analyze continuous data, and the Chi-Square test was used for categorical data analysis. Missing data were excluded from the analysis process. All analyses were performed using the R program. Since the first COVID-19 case in Turkey was detected on March 11, March was divided into two periods for the analysis: March 1-10 and March 11-31. The aim of the study was to analyze the data recorded in the system, mainly regarding the differences in the number of patients who visited the hospital before and after the first COVID-19 case, the differences in the number of admitted patients, the differences in comorbidities, and whether there were differences in the procedures applied to the patients. The study also aimed to provide insights into what could be done in other waves of the pandemic or in other similar events.

Results

A total of 1173 people were included in the study, and Table 1 provides the sociodemographic characteristics and medical histories of the patients.

The month with the highest number of patients admitted to the emergency department was December, while the lowest month was April. In March, 145 patients were recorded, and 51 of these patients applied before the first COVID-19 case in Turkey. From December 2019 until the first COVID-19 case was reported, 627 patients presented to the emergency room, while from March 11, 2020, to July 2020, 506 patients came to the emergency room. Compared to the pre-COVID-19 period, there was an approximate 19% decrease in emergency room visits after COVID-19. Additionally, April, which followed the first COVID-19 case, was the month with the lowest number of patients. The decrease in the number of patients between December 2019 and July 2020 is shown linearly on the graph in Figure 1.

Table 1. The sociodemographic characteristics and medical histories of the patients

		Before COVID-19	After COVID-19		
		Median (25p-75p)	Median (25p-75p)	U	p
Age		61.0 (53.0-69.0)	60.0 (51.0-69.0)	162214.5	0.119
		n (%)	n (%)	X^2	p
Gender	**Male**	467 (52.53)	422 (47.46)	1.260	0.260
	Female	160 (56.33)	124 (43.66)		
Coming from outside Ankara	**No**	63 (57.27)	47 (42.72)	1.600	0.210
	Yes	521 (50.92)	502 (49.07)		
History of DM	**No**	395 (51.76)	368 (48.23)	1.830	0.180
	Yes	215(55.98)	169 (44.01)		
History of HT	**No**	298 (49.58)	303 (50.41)	6.570	0.010
	Yes	312 (57.14)	234 (42.85)		
History of CVE	**No**	591 (53.48)	514 (46.51)	1.870	0.170
	Yes	17 (42.50)	23 (57.50)		
History of HL	**No**	471 (47.72)	516 (52.27)	84.770	<.001
	Yes	139 (86.87)	21 (13.12)		
History of CAD	**No**	380 (52.48)	344 (47.51)	0.470	0.490
	Yes	239 (54.56)	199 (45.43)		
Smoking	**No**	406 (50.68)	395 (49.31)	14.110	<.001
	Yes	193 (63.27)	112 (36.72)		
Blood type	**0 RH +**	111 (50.00)	111 (50.00)	2.520	0.930
	0 RH -	13 (48.14)	14 (51.85)		
	A RH +	168 (52.01)	155 (47.98)		
	A RH -	20 (62.50)	12 (37.50)		
	B RH +	58 (51.78)	54 (48.21)		
	B RH -	6 (54.54)	5 (45.45)		
	AB RH +	26 (46.42)	30 (53.57)		
	AB RH -	3 (50.00)	3 (50.00)		

(DM: Diabetes mellitus, HT: Hypertension, CVE: Cerebrovascular event, HL: Hyperlipidemia, CAD: Coronary artery disease)

Table 2 presents the proportion of patients who presented to the hospital by ambulance or from outside of Ankara, their diagnosis upon admission, LVEF values based on echocardiography and coronary angiography results, including thrombus and TIMI flow rates, and the revascularization status of the patients. The frequency of pre-COVID-19 LVEF being 35 and below (51.85%) and over 35 (53.37%) were higher than post-COVID-19, but this difference was not statistically significant (p=0.700). However, LVEF values were lower in April than in other months, particularly during the first months of the pandemic (Figure 2).

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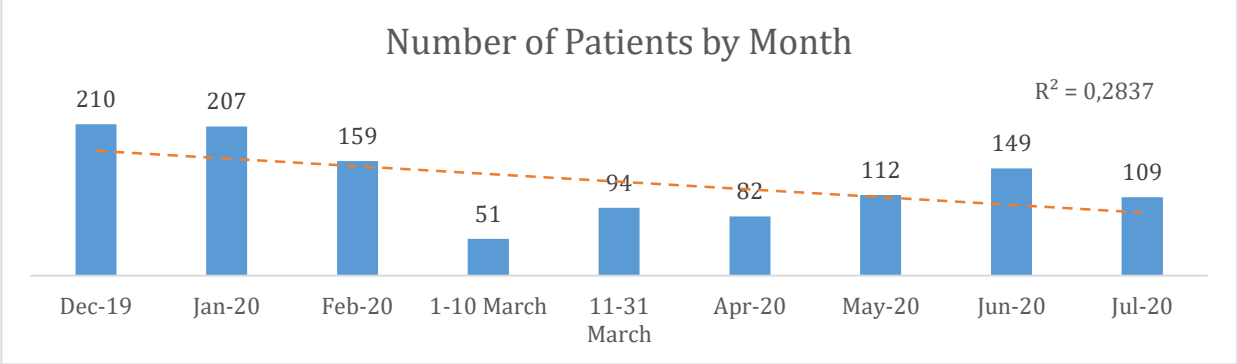

Figure 1. Distribution of the number of patients by months

Table 2. Hospital admission diagnosis and vascular disease status

		Before COVID-19	After COVID-19		
		n (%)	n (%)	X^2	p
Ambulance use	**No**	248 (53.91)	212 (46.08)	1.490	0.223
	Yes	336 (50.22)	333 (49.77)		
Diagnosis	**NSTEMI**	316 (53.28)	277 (46.71)	5.110	0.078
	STEMI	257 (51.72)	240 (48.28)		
	USAP	54 (65.06)	29 (34.93)		
Revascularization*	**0**	17 (26.56)	47 (73.43)	27.700	<.001
	1	500 (55.12)	407 (44.87)		
	2	88 (59.06)	61 (40.93)		
	3	15 (35.71)	27 (64.28)		
Non-culprit intervention	**No**	429 (50.64)	418 (49.35)	9.450	0.002
	Yes	192 (60.75)	124 (39.24)		
Slow flow	**No**	609 (53.00)	540 (47.00)	8.280	0.016
	Yes	11 (91.66)	1 (8.33)		
TIMI grade flow	**0**	96 (42.48)	130 (57.52)	13.800	0.069
	1	3 (50.00)	3 (50.00)		
	2	16 (61.53)	10 (38.46)		
	3	505 (55.86)	399 (44.13)		
Thrombus	**No**	548 (54.52)	457 (45.47)	4.410	0.036
	Yes	71 (45.51)	85 (54.48)		
Three vessel disease	**No**	577 (53.92)	493 (46.07)	1.760	0.185
	Yes	43 (46.73)	49 (53.26)		
LVEF	**35 and Below**	98 (51.85)	91 (48.14)	0.150	0.700
	Above 35	482 (53.37)	421 (46.62)		

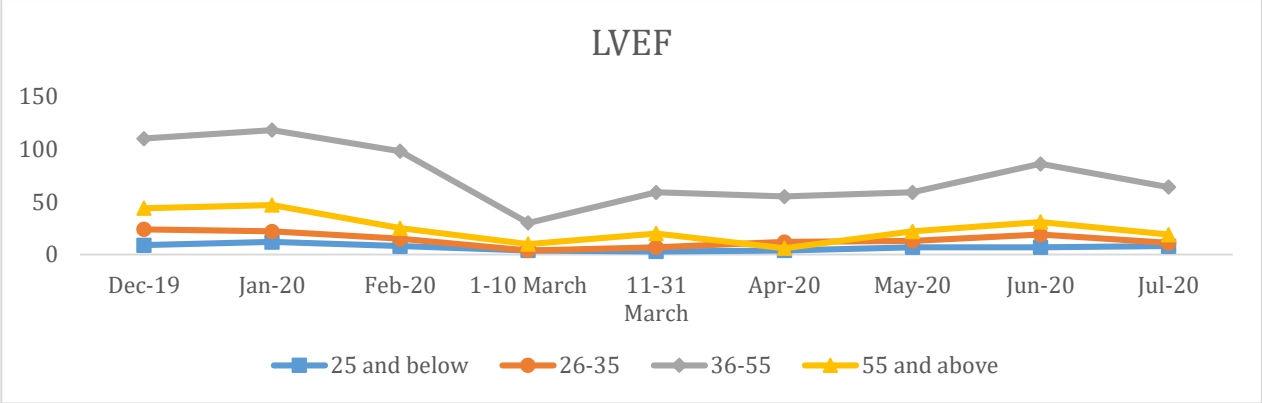

Figure 2. Distribution of LVEF values by months

Patients diagnosed with AMI who were admitted to the hospital were examined in four groups according to their revascularization status: Group 0: Patients who did not undergo coronary angiography, Group 1: Patients who underwent coronary angiography and stent placement, Group 2: Patients who underwent coronary angiography, and non-obstructive stenosis was detected, and Group 3: Patients who decided to have surgery after coronary angiography (Figure 3).

According to the results of the chi-square analysis, when patients were evaluated in terms of having the revascularization procedure or not, not having the procedure was more common after the COVID-19 pandemic, which was found to be statistically significant ($\chi 2$= 19.537, p-value = <0.001) (Figure 4).

Table 3 presents the comparison of blood values of people who applied to the hospital in the pre and post-COVID-19 period.

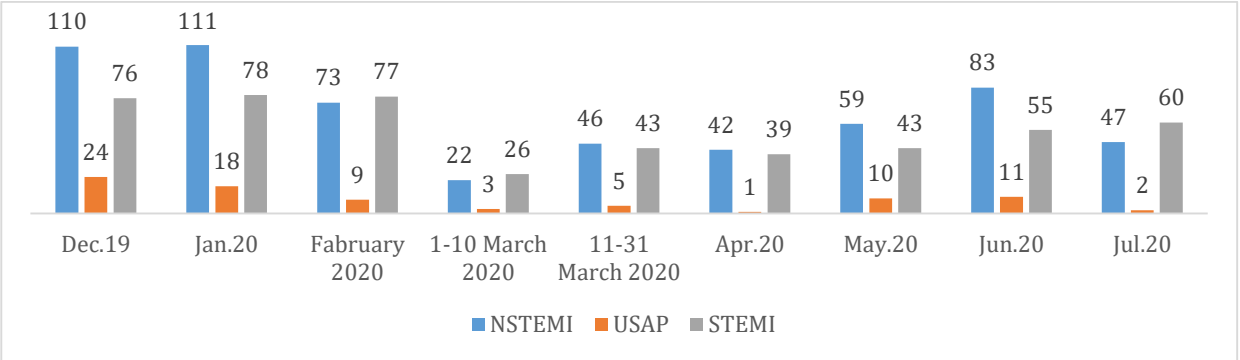

Figure 3. The number of NSTEMI and STEMI before and after pandemic

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The patient groups who underwent coronary angiography were examined in three different groups as patients with medical follow-up, stent implantation, or operation decision. According to the results of the chi-square analysis, stent implantation was more common before the COVID-19 pandemic than after, and there was a significant relationship ($\chi 2$= 7.304, p-value = 0.025). Also, the number of patients who were referred to the operation was higher after the COVID-19 pandemic (Figure 4).

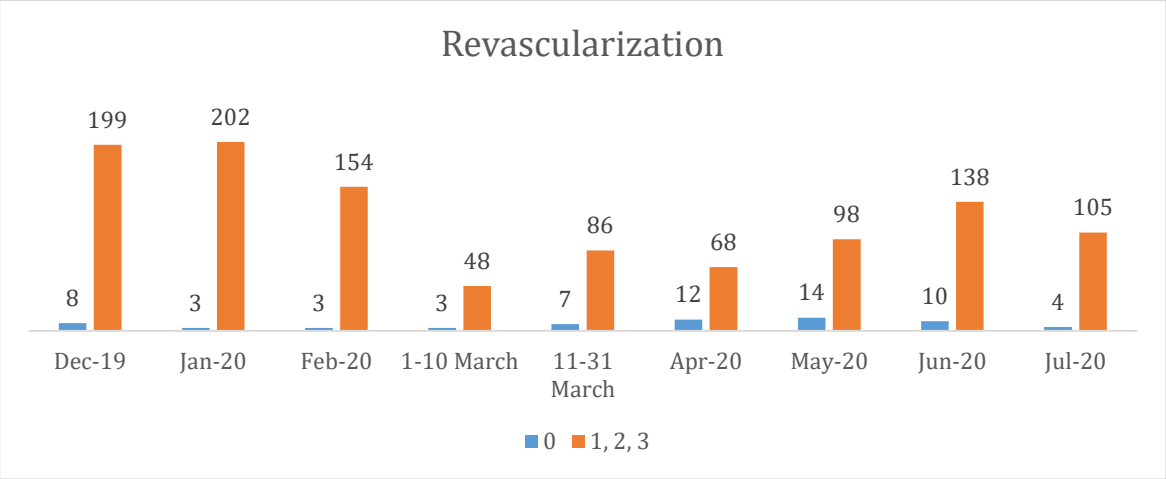

Figure 4. Distribution of the patients as two different groups as those who did not undergo revascularization (Group 0) and those who did (Groups 1-2-3), according to months

Table 3. Laboratory values at the time of admission to the hospital

	Before COVID-19	After COVID-19	p
	Median (25p-75p)	Median (25p-75p)	
Glucose	122 (99-171)	121 (99.8-177)	0.850
GFR	89 (70-100)	89 (67-102)	0.836
WBC	10 (8-13)	10 (8-12)	0.427
Neutrophil	7 (5-10)	7 (5-10)	0.983
Lymphocyte	2 (1-3)	2 (1-2)	0.041
Hemoglobin	14 (13-15)	14 (13-15)	0.065
Total cholesterol	174 (146-204)	182 (153-210)	0.018
LDL	112 (84-138)	118 (89-141)	0.360
HDL	34 (29-41)	34 (29-40)	0.793
Triglyceride	113 (74-172)	131 (84.3-198)	0.002
HS Troponin	1666 (85.3-12549)	2373 (198-14223)	0.057
Albumin	40 (34-43)	41 (37-44)	0.007
AST	34 (23-94)	43 (23-130)	0.011
ALT	23 (12-38.3)	27 (16-41)	0.020

(GFR: Glomerular filtration rate, WBC: White blood cell, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, AST: Aspartate aminotransferase, ALT: Alanine transaminase, HS Troponin: High sensitivity troponin)

Discussion

The results of our study indicate that the number of patients who presented to our hospital with the onset of the pandemic decreased by 50% compared to the previous month on a monthly basis. However, as the pandemic progressed, this decrease gradually declined, and the rate was 19% when compared to the three months before and after the pandemic. Reports from Austria, Italy, and the USA (California) also showed a decrease in hospital admissions for both STEMI and NSTEMI.[5-7] Similarly, studies conducted at the beginning of the pandemic in our country showed a higher decrease compared to previous years. [8-10] The history of hypertension and hyperlipidemia was higher in patients admitted to the hospital in the pre-COVID-19 period, which can be partly explained by the limitations of reaching the hospital that the pandemic brought for patients with accompanying comorbidities during this period. [11] In the medical histories of the patients regarding the risk of coronary artery disease, cigarette smoking significantly decreased after the COVID-19 period. Consistent with the literature, the reason for this situation may be the awareness that was created for the public about this issue after the pandemic.[12]

When examining the data of 1173 patients, it was observed that the revascularization rate of patients had decreased significantly after the COVID-19 pandemic. Additionally, thrombosed lesions in the coronary angiography findings of revascularized patients had increased statistically. Although the number of patients with three-vessel lesions was not statistically significant, a slight increase was observed after the pandemic. The reasons for this were thought to be related to the effect of the curfew and patients arriving late at the hospital due to the fear of contracting a COVID-19 infection while in the hospital. [13,14] After the pandemic, the incidence of slow flow was statistically less frequently observed. The analyses showed that patients underwent surgery more frequently after the pandemic, while stenting was performed less frequently. Based on these data, it can be said that more critical and thrombosed lesions were observed, resulting in an increase in patients with lesions with high SYNTAX scores after the pandemic. Thus, more patients underwent surgery, while stenting was performed less frequently. The frequency of thrombosed lesions increased statistically significantly after the pandemic. One of the reasons for this is patients who were infected with COVID-19 after the pandemic and were treated with a diagnosis of acute coronary syndrome. It is known in the literature that COVID-19 increases arterial and venous thromboembolism events due to the fact that it causes hypercoagulability, especially endothelial damage through the ACE-2 receptor. [15,16]

When comparing on a monthly basis, the highest number of patients with low LVEF was seen in April, which may have been due to the late admission of these patients at the beginning of the pandemic due to restrictions, hospitals being unprepared, and patients being reluctant to seek medical care. However, in the months following the onset of the pandemic, LVEF values started to be similar. During the pandemic, the frequency of intervention on non-culprit lesions was statistically lower. [17-19] This situation may have decreased after the

onset of the pandemic due to most doctors being assigned to different clinics, the risk of contracting COVID-19 during long procedures, the need to prevent transmission in the hospital, and the postponement of all elective procedures by the Ministry of Health. In the literature, it has been shown that the number of percutaneous coronary procedures performed during the COVID-19 pandemic in many countries has decreased. [20-22]

There was no change in the average duration of hospitalization of patients before or after the pandemic, but the duration of hospital stay was more stable before the pandemic. This situation can be explained by the fact that the hospitalization of some patients was prolonged due to the need for extra tests owing to similar symptoms that may have developed on the basis of MI, which could also be seen in COVID-19 infection. Additionally, some patients may have been discharged from the hospital earlier to reduce transmission. [23]

A statistically significant decrease was observed in lymphocyte counts after the COVID-19 pandemic (p=0.041). This may have been due to the fact that COVID-19-positive patients were also treated during the COVID-19 period, and lymphocyte deficiency could be observed in these patients. Additionally, low lymphocyte levels were indicative of a bad inflammatory process, and delayed medical applications may have contributed to the decrease.[24] Although no significant differences were observed in hemogram parameters other than lymphocyte values, troponin levels, liver function tests, and lipid levels of the patients were higher after the pandemic than before. This situation was primarily explained by the late arrival of patients. [11]

Pandemics are a persistent global concern that may recur if preventive measures are inadequate, as demonstrated by epidemiological studies. This study aimed to illustrate the potential repercussions of not intervening in high-mortality diseases, such as acute coronary syndrome, during ongoing and future pandemics due to insufficient protective measures. Our research recommends that patients with severe symptoms seek medical attention promptly, even during a pandemic, while also minimizing hospital occupancy rates.

Limitations

The most significant limitation of the study was the unavailability of the patient's records from the onset of their symptoms until the balloon procedure was performed during angiography. As a result, factors such as the duration of processing after the pandemic, longer waiting times in the emergency room, and patients' delayed arrival at the hospital could not be directly evaluated. The study attributed findings such as lower LVEF values and higher rates of blood values associated with poor prognosis at the beginning of the pandemic to patients' late arrival, longer waiting times in the emergency department, and delayed processing. Additionally, the study was limited by the lack of data on mortality rates before and after the pandemic, which prevented the comparison of patients hospitalized with the diagnosis of acute coronary syndrome.

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Ethical Considerations: Ethics committee approval was obtained from Ankara Yıldırım Beyazıt University Clinical Research Ethical Committee (Decision Date:07/10/2020, Decision Number:26379996/110)

Conflict of Interest: The authors declare no conflict of interest.

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