INTRODUCTION

Acute ST-segment elevation MI (STEMI) is the most dramatic clinical presentation of atherosclerotic heart disease. Rapid myocardial injury usually occurs caused by an acute occluded coronary artery. Since the myocardial damage is irreversible most of the time, the infarct-related artery (IRA) should be recanalised immediately.\(^1\)\(^,\)\(^2\) Therefore, current guidelines strongly recommend a time-dependent algorithm from the onset of symptoms.\(^3\) However, the time lost between symptom onset and treatment initiation interacts with many factors connected to both the patient and the healthcare system.\(^4\)\(^,\)\(^5\)

The coronavirus disease (COVID-19), which started in Wuhan, China, in December 2019, has turned into a worldwide pandemic.\(^6\) As of May 10, around 4 million people became infected and nearly three hundred thousand people died globally as a result of the spread of the virus.\(^7\) As a definitive treatment and vaccine against Covid-19 virus has not been developed yet, it has become the main policy to prevent the spread of the virus worldwide. Patients were especially advised to stay away from environments such as hospitals with high contact risk, as much as possible. Therefore, isolation recommendations during the Covid-19 outbreak may have negatively affected the time curve of STEMI patients. In a recent cohort, it was observed that there was a significant decrease in the rate of patients admitted to the hospital in the first 48 hours after lockdown because of Covid-19.\(^8\) In the study presented, the pre- and postpandemic time parameters of STEMI patients in our region were examined.
During the study period, routine PCR tests were not applied to asymptomatic STEMI patients in our country.  
Ethical Committee Approval for this study was granted by the Ondokuz Mayis University Hospital Ethics Committee.

### 2.4 Statistical analysis

Statistical analysis was carried out using Statistical Package for the Social Sciences for Windows 15.0 (SPSS Inc Chicago, Illinois, USA). Descriptive statistics were provided as median (min-max), mean ± SD and percentage. The Kolmogorov-Smirnov test was used for normal distribution analysis of the data. Non-parametric Mann-Whitney U-test was used for non-normally distributed data, and sample t-test was used for normally distributed data. For categorical data, chi-square test was used. Kruskal-Wallis Test was used to compare patients who were divided into 3 groups according to the Covid-19 infection status. Values of $P < .05$ were considered statistically significant.

### 3 RESULTS

A total of 165 patients, 82 in the Pandemic period and 83 in the Control period, were included in the study. Age, gender, frequency of diabetes, anterior MI rate, choice of P2Y12 and use of glycoprotein inhibitors (GPI) were similar among the groups. Of the patients in the pandemic period, 57 (69.5%) were admitted in the control period, while 23 (28%) were suspected Covid-19 and 2 (2.4%) confirmed Covid-19.

Patients were found to have significantly higher rates of ambulance use during the pandemic period (45.1% and 28.9% $P = .031$). In the first stage, the number of patients who reached the PPCI-capable centre was also higher during the pandemic period (28.1% vs 13.3% $P = .019$) (Table 1).

In terms of treatment strategies, PPCI was performed to 73 (89%) patients in the pandemic period and 80 (96.4%) patients in the control period. While 9 (11%) patients were treated with thrombolytic or emergency coronary bypass surgery (e-CABG) in the pandemic period, this number was only 3 (3.6%) in the control period ($P = .069$).

When the components of the ischemic time were examined, home delay was 30 (5-6912) minutes in the control period, whereas 165 (10-360) minutes in the pandemic period ($P < .001$). FMC delay was 61 (20-6932) minutes in the control period and 190 (15-3660) minutes in the pandemic period ($P < .001$). While the number of patients with FMC delay $> 120$ minutes was 24 (29.3%) in the control period, it increased to 54 (65.9%) in the pandemic period ($P < .001$). In addition, door-to-balloon time was 83 (28-488) minutes in the pandemic period, while it was 69 (11-455) minutes in the control period ($P = .076$) (Figure 1) (Table 2).

There was no significant difference between the groups in terms of IRA detected during the angiography of the patients ($P = .478$). The non-IRA intervention rate during the index procedure was...
significantly lower during the pandemic period (8.8% vs 19.3% \( P = .043 \)). No reflow developed in 5 (6.3%) patients during the pandemic period and in 4 (4.9%) patients before the pandemic period \( (P = .703) \). The median procedure time was 27.5 (5-77) minutes during the pandemic period, while it was 26 (9-71) minutes in the prepandemic period \( (P = .373) \).

**TABLE 1** Basal characteristics of groups

| Clinical data          | Covid-19 Period (n = 82) | Control Period (n = 83) | \( P \) |
|------------------------|--------------------------|-------------------------|--------|
| Age (years)            | 61.2 ± 11.4              | 60.7 ± 10.5             | .771   |
| Men, n (%)             | 61 (74.4)                | 61 (73.5)               | .896   |
| Diabetes mellitus, n (%)| 28 (34.1)                | 27 (32.5)               | .826   |
| Hypertension, n (%)    | 58 (70.7)                | 55 (66)                 | .615   |
| Current smoking, n (%) | 31 (37.8)                | 37 (44.5)               | .430   |
| Prior MI, n (%)        | 10 (12)                  | 7 (8.4)                 | .454   |
| Anterior STEMI, n (%)  | 32 (39)                  | 35 (42.2)               | .681   |
| Transport with ambulance, n (%) | 37 (45.1) | 24 (28.9) | .031 |
| Direct PCI centre, n (%) | 23 (28.1)              | 11 (13.3)               | .019   |
| Distance to PCI centre (km) | 40 (6-114)           | 40 (8-114)              | .257   |

| Drug                   | Covid-19 Period (n = 82) | Control Period (n = 83) | \( P \) |
|------------------------|--------------------------|-------------------------|--------|
| GPI, n (%)             | 16 (20)                  | 22 (27.2)               | .285   |
| P2Y12, n (%)           | 42 (51.9)                | 49 (59.8)               | .381   |
| Clopidogrel, n (%)     | 31 (38.3)                | 29 (35.4)               |        |
| Ticagrelor, n (%)      | 8 (9.9)                  | 4 (4.9)                 |        |

Note: Abbreviations: GPI, glycoprotein inhibitors; PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction.

In terms of postprocedural parameters, the hospitalisation time was calculated shorter during the pandemic period \[71 (15-170) \text{ hours} vs 74.2 (37-329) \text{ hours} \( P = .045 \)]. In-hospital mortality was not different between the groups and acute stent thrombosis was not observed in any case.

When patients were grouped according to the Covid-19 infection status, there were significant differences in confirmed or suspected Covid-19 cases in terms of home delay \( P < .001 \), FMC delay \( P < .001 \), door-to-balloon time \( P = .015 \) and hospitalisation time \( P = .037 \). However, the procedure time was similar between the groups (Table 3) (Figure 2).

**DISCUSSION**

In our study, changes in prehospital delays and treatment applications were determined in STEMI patients who applied during the Covid-19 pandemic period. While home delay and FMC delay increased during the pandemic period, non-IRA PCI rate and discharge time were decreased. On the other hand, there was no significant change in door-to-balloon time and procedure time. To the best of our knowledge, this is the first randomised controlled study to analyse these parameters.

Studies have shown that the delay in FMC is associated with an increase in mortality and complication rate.\(^{10,11}\) Candiello et al\(^{12}\) reported the median FMC delay time in their study as 75 minutes, while Pereira et al\(^{13}\) reported as 114 minutes. In the study of Viana et al,\(^{10}\) the STEMI rate with FMC delay below 120 minutes was found to be 56.7%. In our study, in order to understand the patient-related delay better, we calculated another time that we defined as home delay in addition to FMC delay. In our study, home delay and FMC delay were prolonged compared with the prepandemic period. In addition, the rate of patients with FMC delay time > 120 minutes during the...
pandemic period was doubled. In the report published by Tam CF et al during the Covid-19 outbreak, FMC delay was reported as 82.5-91.5 minutes before the pandemic period, whereas 318 minutes during the pandemic period. However, this report showed that only 7 STEMI patients were analysed during the pandemic period. In our study, it was noticeable that the delay in the prehospital period was more evident in the home-delay stage. During the Covid-19 pandemic period, “Stay at home” calls were made to increase social isolation compliance. Therefore, many of the STEMI patients in the pandemic period seemed to have made their decision to go to the hospital later in their symptoms.

The mode that STEMI patients prefer for transportation to the hospital affects ischemic time. It has been reported that total ischemic time of patients transported by ambulance was shorter and the rate of transportation to the correct centre was higher. However, in studies conducted in our country, it was demonstrated that STEMI patients preferred self-transport rather than ambulance. In our study, the transportation of the patients by ambulance was 28.9% in the prepandemic period and 45.1% during the pandemic period. This may be because of the fact that social isolation measures during the pandemic period, such as curfews, increased the ambulance use. In addition, the rate of transportation to a PCI-capable centre in parallel with the use of ambulance also increased during the pandemic period. However, during the pandemic period, only a quarter of the patients reached the centre that performed PPCI in the first stage.

Another determinant of the ischemic time depends on the practices of the centre performing PCI. Prolongation in this period is mostly related to delays in Emergency Medical Services (EMS). The door-to-balloon time calculated in our study during the pandemic period increased numerically but did not reach statistical significance (P = .076). However, this period was significantly higher in patients with confirmed or suspected Covid-19. The reason for this may be the prolongation of the process with chest imaging, nasopharyngeal swab sampling and infection department consultation before being taken to the catheter.

### TABLE 2  Treatment and time parameters of groups

|                          | Covid-19 Period (n = 82) | Control Period (n = 83) | P     |
|--------------------------|--------------------------|-------------------------|-------|
| Primary Revascularization strategy | .069                     |                         |       |
| Primary PCI, n (%)       | 73 (89)                  | 80 (96.4)               |       |
| Thrombolytic or e-CABG, n (%) | 9 (11)                  | 3 (3.6)                 |       |
| Preprocedural Time parameters |                         |                         |       |
| Home delay, min (min-max) | 165 (10-3600)            | 30 (5-6912)             | <.001 |
| FMC delay, min (min-max) | 190 (15-3660)            | 61 (20-6932)            | <.001 |
| Door-to-balloon time, min (min-max) | 83 (28-488)            | 69 (11-455)             | .076  |
| Procedural parameters    |                         |                         |       |
| Left main coronary artery, n (%) | 1 (1.3)                | 0                       | .478  |
| Left anterior descending artery, n (%) | 31 (38.8)              | 34 (41.5)               |       |
| Left circumflex artery, n (%) | 15 (18.8)              | 13 (15.9)               |       |
| Right coronary artery, n (%) | 31 (38.8)              | 35 (42.7)               |       |
| Saphenous vein graft, n (%) | 2 (2.5)                | 0                       |       |
| Syntax I score           | 17.3 ± 5.1              | 16.9 ± 4.5              | .602  |
| Non-IRA PCI, n (%)       | 7 (8.8)                 | 16 (19.3)               | .043  |
| No reflow, n (%)         | 5 (6.3)                 | 4 (4.9)                 | .703  |
| Procedure time, min (min-max) | 27.5 (5-77)            | 26 (9-71)               | .373  |
| Postprocedural parameters |                         |                         |       |
| Hospitalization time, h (min-max) | 71 (15-170)            | 74.2 (37-329)           | .045  |
| Hospital death, n (%)    | 6 (7.3)                 | 3 (3.7)                 | .304  |
| Acute stent thrombosis, n (%) | 0                      | 0                       |       |

Abbreviations: e-CABG, emergency coronary artery bypass grafting surgery; FMC, first medical contact; IRA, infarct-related artery; PCI, percutaneous coronary intervention.

### TABLE 3  Comparisons of time parameters in patients according to Covid-19 status

|                          | Covid-19 period | Control period | P     |
|--------------------------|-----------------|----------------|-------|
|                          | Covid-19 positive or susceptible (n = 25) | Considered Covid-19 negative (n = 57) | Control period (n = 83) |       |
| Home delay, min (min-max) | 180 (20-2880)a  | 150 (10-3600)b | 30 (5-6912) | <.001 |
| FMC delay, min (min-max) | 210 (20-2940)a  | 150 (15-3660)b | 61 (20-6932) | <.001 |
| Door-to-balloon time, min (min-max) | 118 (40-488)b   | 73 (28-260)   | 69 (11-455) | .015  |
| Procedure time, min (min-max) | 26.5 (13-54)   | 29 (5-77)     | 26 (9-71) | .714  |
| Hospitalization time, h (min-max) | 80 (37-160)     | 70 (15-124)b  | 74.2 (37-329) | .037  |

Abbreviation: FMC, first medical contact.

aCompared with group III P < .016.
bCompared with group II P < .016.
Another potential cause of delay is using of the personal protection equipment of the team that perform the intervention to these patients. A Korean study on the MERS-CoV epidemic period stated that potential difficulties in the use of protective equipment affect healthcare delivery. On the other hand, it may be thought that the rapid triage habits of the centres in STEMI patients may have prevented the significant prolongation in the door-to-balloon time.

In the outbreak period, numerical increase tendency was observed in thrombolytic or emergency surgical revascularisation applications as a method of revascularisation. The reason for this may be the operator concern about contamination and publications recommending thrombolytic therapy. Current European guidelines do not recommend routine non-IRA PCI during index procedure in patients with multivessel disease presenting with STEMI. However, because of contradictory data in research, the complexity of the case, the experience and preference of the operator are also effective in practice. In our study, the rate of non-IRA PCI during the index procedure significantly decreased during the pandemic period compared with the prepandemic period. This is most likely related to the operator’s tendency to shorten catheter time to reduce the risk of transmission. A similar situation was observed in the discharge time of the patients. It was noteworthy that the discharge time was shorter, especially for Covid-19-negative patients.

Finally, the procedure time during the pandemic period did not change compared with the prepandemic period. Although the number of non-IRA interventions was less during the pandemic period, the procedure time was found to be numerically longer. This may be related to the protective measures taken against the virus in the catheter laboratory during the pandemic period and the more controlled and slower work of the staff against the risk of transmission.

4.1 Study limitation

The data obtained in our study belonged only to 3 centres in two cities. During the study period, as seen in some metropolitan cities of the world, there was no tragic pandemic intensity in these two cities. Therefore, the data obtained may not reflect more intense outbreak areas.

In the study, the same months of the year before and after the pandemic were not analysed. Considering the seasonal character of STEMI, this may partially affect the outcome.

5 Conclusion

The Covid-19 outbreak has emerged as a virus infection with high risk of transmission and has spread rapidly around the world. It is not surprising that both patient and physician behaviours are affected during this pandemic period, since the transmission and mortality rates are higher among healthcare professionals. In our study, it has been determined that ischemia times in STEMI patients, especially in the patient-related part, are prolonged during the pandemic period. Therefore, informing the public about heart attack symptoms as a part of the outbreak measures may reduce possible delays.

Disclosure

None to declare.

Data Availability Statement

Data available on request from the authors.

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