CORRESPONDENCE

ST-Segment Elevation in Patients with Covid-19 — A Case Series

TO THE EDITOR: Myocardial injury with ST-segment elevation has been observed in patients with coronavirus disease 2019 (Covid-19). Here, we describe our experience in the initial month of the Covid-19 outbreak in New York City.

Patients with confirmed Covid-19 who had ST-segment elevation on electrocardiography were included in the study from six New York hospitals. Patients with Covid-19 who had nonobstructive disease on coronary angiography or had normal wall motion on echocardiography in the absence of angiography were presumed to have noncoronary myocardial injury.

We identified 18 patients with Covid-19 who had ST-segment elevation indicating potential acute myocardial infarction (Fig. S1 in the Supplementary Appendix, available with the full text of this letter at NEJM.org). The median age of the

Table 1. Characteristics of 18 Patients with Covid-19 with ST-Segment Elevation on Electrocardiography.*

Characteristic	Total (N=18)	Myocardial Infarction (N=8)	Noncoronary Myocardial Injury (N=10)
Median age (IQR) — yr	63 (54–73)	60 (56–73)	66 (54–73)
Male sex — no. (%)	15 (83)	7 (88)	8 (80)
Race or ethnic group — no. (%)†			
White	4 (22)	1 (12)	3 (30)
Black	2 (11)	1 (12)	1 (10)
Hispanic	9 (50)	4 (50)	5 (50)
Asian	3 (17)	2 (25)	1 (10)
Risk factor — no. (%)‡			
Hypertension	11/17 (65)	6/7 (86)	5/10 (50)
Diabetes mellitus	6/17 (35)	3/7 (43)	3/10 (30)
Hypercholesterolemia	7/17 (41)	2/7 (29)	5/10 (50)
History of coronary artery disease	3/17 (18)	0/7	3/10 (30)
Smoking	1/17 (6)	1/7 (14)	0/10
Chronic obstructive pulmonary disease	0/17	0/7	0/10
Chronic kidney disease	1/17 (6)	1/7 (14)	0/10
Signs and symptoms around the time of ST-segment elevation — no. (%)			
Chest pain	6 (33)	5 (62)	1 (10)
Fever	13 (72)	6 (75)	7 (70)
Cough, shortness of breath, or respiratory distress	15 (83)	6 (75)	9 (90)
Intubation§	12 (67)	5 (62)	7 (70)
Shock	7 (39)	2 (25)	5 (50)
Cardiac arrest	2 (11)	1 (12)	1 (10)

Table 1. (Continued)

Characteristic	Total (N=18)	Myocardial Infarction (N=8)	Noncoronary Myocardial Injury (N=10)
Electrocardiographic findings — no. (%)			
Diffuse ST elevations	4 (22)	0	4 (40)
Focal elevations	14 (78)	8 (100)	6 (60)
Anterior	3 (17)	1 (12)	2 (20)
Inferior	8 (44)	4 (50)	4 (40)
Lateral	9 (50)	8 (100)	1 (10)
Echocardiographic findings — no. (%)¶			
Normal ejection fraction	8/17 (47)	1/8 (12)	7/9 (78)
Low ejection fraction	9/17 (53)	7/8 (88)	2/9 (22)
Regional wall-motion abnormality	6/17 (35)	6/8 (75)	0/9
Coronary angiography — no. (%)	9 (50)	6 (75)	3 (30)
Obstructive coronary artery disease — no./total no. (%)	6/9 (67)	6/6 (100)	0/3
Percutaneous coronary intervention — no./total no. (%)	5/9 (56)	5/6 (83)	0/3
Findings on radiography of the chest — no. (%)			
Opacities in both lungs	14 (78)	6 (75)	8 (80)
Focal opacity	1 (6)	0	1 (10)
Normal	3 (17)	2 (25)	1 (10)
Median laboratory values (IQR)‖			
White-cell count — $\times 10^{-3}/mm^3$	8.8 (6.4–11.0)	10.0 (7.9–13.5)	8.3 (5.8–9.1)
Neutrophils — %	85.5 (78.8–88.2)	86.1 (73.5–88.6)	85.0 (81.5–87.9)
Lymphocytes — %	7.4 (6.0–13.1)	8.2 (6.7–15.0)	7.3 (6.0–11.1)
Peak troponin I — ng/ml	44.4 (13.3–80.0)	91.0 (65.6–345.0)	13.5 (4.8–41.0)
Peak troponin T — ng/ml	4.4 (2.2–6.3)	6.3 (5.3–7.2)	0.02 (0.02–0.02)
D-Dimer — ng/ml	858 (652–4541)	1909 (682–19,653)	858 (541–3580)
Treatment — no. (%)			
Fibrinolytic agent	1 (6)	1 (12)	0
Glucocorticoids	5 (28)	1 (12)	4 (40)
Hydroxychloroquine	14 (78)	5 (62)	9 (90)
Azithromycin	14 (78)	5 (62)	9 (90)
Statins	11 (61)	5 (62)	6 (60)
Death in the hospital — no. (%)	13 (72)	4 (50)	9 (90)

* Percentages may not total 100 because of rounding. Covid-19 denotes coronavirus disease 2019, and IQR interquartile range.
† Race and ethnic group were reported by the patient or were determined by the physician for one patient who was unresponsive.
‡ Risk factors were unknown for one patient, who was found unresponsive at home; investigators were unable to reach any family members for information.
§ Patients who were intubated had limited history available.
¶ One patient did not have an echocardiogram.
‖ The troponin assay was troponin I in 15 patients and troponin T in 3 patients. The reference value for the troponin I level was 0.06 ng per milliliter or less. The reference value for the troponin T level was 0.01 ng per milliliter or less. The reference value for the D-dimer level was 230 ng per milliliter or less.

patients was 63 years, 83% were men, and 33% had chest pain around the time of ST-segment elevation (Table 1). A total of 10 patients (56%) had ST-segment elevation at the time of presentation, and the other 8 patients had development of ST-segment elevation during hospitalization (median, 6 days) (Fig. S2A).

Of 14 patients (78%) with focal ST-segment

elevation, 5 (36%) had a normal left ventricular ejection fraction, of whom 1 (20%) had a regional wall-motion abnormality; 8 patients (57%) had a reduced left ventricular ejection fraction, of whom 5 (62%) had regional wall-motion abnormalities. (One patient did not have an echocardiogram.) Of the 4 patients (22% of the overall population) with diffuse ST-segment elevation, 3 (75%) had a normal left ventricular ejection fraction and normal wall motion; 1 patient had a left ventricular ejection fraction of 10% with global hypokinesis.

A total of 9 patients (50%) underwent coronary angiography; 6 of these patients (67%) had obstructive disease, and 5 (56%) underwent percutaneous coronary intervention (1 after the administration of fibrinolytic agents) (Fig. S3). The relationship among electrocardiographic, echocardiographic, and angiographic findings are summarized in Figure S4. The 8 patients (44%) who received a clinical diagnosis of myocardial infarction had higher median peak troponin and D-dimer levels than the 10 patients (56%) with noncoronary myocardial injury (Fig. S2B and S2C). A total of 13 patients (72%) died in the hospital (4 patients with myocardial infarction and 9 with noncoronary myocardial injury).

In this series of patients with Covid-19 who had ST-segment elevation, there was variability in presentation, a high prevalence of nonobstructive disease, and a poor prognosis. Half the patients underwent coronary angiography, of whom two thirds had obstructive disease. Of note, all 18 patients had elevated D-dimer levels. In contrast, in a previous study involving patients who presented with ST-segment elevation myocardial infarction, 64% had normal D-dimer levels.[1] Myocardial injury in patients with Covid-19 could be due to plaque rupture, cytokine storm, hypoxic injury, coronary spasm, microthrombi, or direct endothelial or vascular injury.[2] Myocardial interstitial edema has been shown on magnetic resonance imaging in such patients.[3]

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