Acute Myocardial Infarction during the COVID-19 Pandemic

Subjects: Cardiac & Cardiovascular Systems

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Coronavirus disease 2019 (COVID-19) was a global pandemic with high mortality and morbidity that led to an increased health burden all over the world. Although the virus mostly affects the pulmonary tract, cardiovascular implications are often observed among COVID-19 patients and are predictive of poor outcomes. Increased values of myocardial biomarkers such as troponin I or NT-proBNP were proven to be risk factors for respiratory failure. Although the risk of acute coronary syndromes (ACSs) was greater in the acute phase of COVID-19, there were lower rates of hospitalization for ACSs, due to patients' hesitation in presenting at the hospital. Hospitalized ACSs patients with COVID-19 infection had a prolonged symptom-to-first-medical-contact time, and longer door-to-balloon time. The mechanisms of myocardial injury in COVID-19 patients are still not entirely clear; however, the most frequently implicated factors include the downregulation of ACE2 receptors, endothelial dysfunction, pro-coagulant status, and increased levels of pro-inflammatory cytokines.

Keywords: COVID-19 ; myocardial infarction ; cardiovascular burden ; acute coronary syndromes

1. Introduction

By June 2023, more than seven hundred million people were infected with coronavirus, and more than six million deaths had been registered worldwide [1].

Although the virus primarily affects the respiratory tract, causing a mild-to-severe case of pneumonia and ultimately severe acute respiratory syndrome (SARS), myocardial injury is frequently observed in patients with COVID-19 (defined as increased levels of cardiac necrosis biomarkers, especially high-sensitivity troponin). One of the implicated mechanisms is the fact that angiotensin-converting enzyme 2 (ACE2) works as a receptor for coronavirus, and that this enzyme is highly expressed in the heart and lungs [2].

Studies have shown that an increase in troponin levels among COVID-19 patients was associated with higher mortality [3]. Myocardial injury can have different electrocardiographic expressions, from a normal EKG to an ST-elevated acute myocardial infarction.

Previous studies reported that viral infections involving the respiratory tract are potential risk factors for acute coronary syndromes (ACSs). One of the possible mechanisms of type 1 AMI (acute myocardial infarction) is the pro-inflammatory state, which can promote the destabilization of a coronary atherosclerotic plaque [4]. Type 2 AMI, also known as myocardial infarction with non-obstructive coronary arteries (MINOCA), could be promoted by hypoxia, tachycardia, and hypotension—symptoms that appear in acute respiratory failure [5].

In SARS-CoV-2 infection, there are particular pathways that can induce AMI, such as endothelial and microvascular injuries, coronary vasospasm, thrombosis, increased platelet consumption, and the cytokine storm [6]. However, there is little information about the post-SARS-CoV-2 infection sequelae. Due to the multiple pathophysiological mechanisms involved in the occurrence of ischemic coronary disease that appear as a result of SARS-CoV-2 infection, researchers considered it important to evaluate the implications of the coexistence of these two entities.

2. Long-Term Risk of Myocardial Infarction

In the studied population, researchers' observed that the majority of patients were males, but even so, females more frequently developed arrhythmias, such as atrial fibrillation, atrial flutter and sinus tachycardia [7][8][9].

The NACMI only studied STEMI patients, and one of the main observations was that in the COVID-19 group, only 20% of the patients required coronary stent implantation, while the rest did not present any culprit lesion at the coronarography. In the COVID-19-negative group with STEMI, 93% needed stent implantation [10]. The in-hospital cardiovascular death was twice as high among COVID-19 patients, with a negative short-term prognosis; one out of three patients who survived the acute event were deceased at the 30-day follow-up. More than one-third of COVID-19 patients with STEMI presented recurrent MI within 30 days (**Table 1**). More than 30% of COVID-19 patients met the primary endpoint, compared to 5% of non-COVID-19 patients [10].

Table 1. Long-term risk of myocardial infarction in COVID-19 survivors.

Authors	1. Garcia S. et al. [10]	2. Xie Y. et al. [7]	3. CinarT. et al. [11]	3. Kiris T. et al. [12]	4. Wang W. et al. [9]
COVID-19 (+)/COVID-19 (−)	230/436	153,760/5,637,647	112/609	1686/62	691,455/2,249,533
Male/Female	71%/29%	89%/11%	55%/45%	75%/25%	43.2%/56.8%
MACE (COVID+/COVID−)	33%/18%	Hazard Ration 1.26 (CI 95%) for non-hospitalized COVID+/2.41 for hospitalized COVID + patient	21.3%/6.3%	22%/22%	Hazard Ratio (CI = 95%) in COVID-19+ was 2.26
30-day Outcome	1 out of 3 COVID-19 (+) patients deceased	Incidence of MI increases 3 times for post-COVID-19 patients	Mortality COVID-19 = 21%. Non-COVID-19 = 7.1%	NA	HR for MI at 30-days outcome = 2.32, HR for death at 30 days = 2.067
Incidence of Miocardial Infarcion in COVID-19 (+) Patient Non-Hospitalized/Hospitalized	NA	3 times higher MI incidence in hospitalized MI patients	NA	NA	Similar MI incidence for hospitalized/non-hospitalized COVID-19+
Incidence of Miocardial Infarction at 12-Month Follow-up	NA	Hazard Ratio (CI 95%) 1.71, burden/1000 pers at 12 M 7.59 for COVID-19+ survivors	NR	6.5% pre-COVID era/5.3% in COVID era	HR (95% CI) = 1.49

Wei et al. [8] observed that increased Troponin I was a negative prognostic factor for COVID-19 patients, leading more often to the need for mechanical ventilation, the use of vasoactive agents and longer admission to ICU (intensive care units).

Patients with COVID-19 disease showed an increased risk of developing acute myocardial infarction within 30 days from the primary infection (HR = 2.32, burden 2.91/1000 patients), regardless of the severity of the respiratory disease. It was detected that the incidence of MI increased with the severity of the viral pneumonia. The pathological mechanism is still unclear; several studies identified micro-thrombosis of small coronary arteries as part of the pro-coagulability status. Except for myocardial infarction, other forms of ischemic heart disease, such as acute coronary disease (ACD), ischemic cardiomyopathy and angina, were more frequent than in the pre-COVID period and in the control groups. The incidence of this diseases is twice as high in COVID-19 survivors.

The long-term burden of MI in COVID-19 survivors remains high even at 12 months after the resolution of the infective disease; this group of patients showed almost twice the risk of developing MI within a year (HR = 1.71, burden = 7.59/1000 patients).

The risk factors for acute myocardial infarction after COVID-19 disease are: older age, diabetes mellitus, male gender and follow-up length [12].

3. Long-Term Outcomes of Post-COVID-19-Positive Patients

Atrial fibrillation was found to be twice as frequent in post-COVID-19 patients. Although the incidence of other arrhythmias increased as well, AF was the most common one [9]. Female COVID-19 survivors and younger patients have shown greater risks of developing myocarditis and arrhythmias than male survivors. Older age survivors have shown an increased risk of developing pulmonary embolism and ischemic heart disease (HR = 1.87) (**Table 2**).

Table 2. Long-term outcomes of post-COVID-19-positive patients.

Study	1. Xie Y. et al. [7]	2. Wang W. et al. [9]	3. Garcia S et al. [10]	4. Kiris T et al. [12]
Mace	**HR (CI 95%) = 1.55 (COVID-19 + 67.67 vs. COVID-19 − 44.19)**	**10,530 patients HR = 1.871**	**36%**	**22%**
Cerebrovascular	**HR = 1.53 (COVID-19 + 15.95 vs. COVID-19 − 10.48)**	**4793 patients HR = 1.68**	**5%**	**1%**
Arhythmyas	**HR = 1.69 (COVID-19 + 49.37 vs. COVID-19 − 29.51)**	**20,927 patients HR = 2.407**	**NA**	**NA**
Ischemic heart disease	**HR = 1.66 (COVID-19 + 18.47 vs. COVID-19 − 11.19)**	**3651 patients HR = 2.8**	**6% (Recurrent MI and unplanned revascularization)**	**15% (Recurrent MI, unplanned revascularization)**
Heart failure	**HR = 1.72 (COVID-19 + 27.92 vs. COVID-19 − 16.31)**	**5831 patients HR = 2.29**	**54%**	**12%**
Thrombotic disease	**HR = 2.39 (COVID-19 + 17.07 vs. COVID-19 − 7.19**	**4599 patients HR = 2.64**	**NA**	**NA**
Cardiac arrest	**HR = 2.45 (COVID-19 + 1.20 vs. COVID-19 − 0.49)**	**474 patients HR = 1.75**	**11%**	**8.50%**
Cardiogenic shock	**HR = 2.43 (COVID-19 + 0.87 vs. COVID-19 − 0.36)**	**204 patients HR = 1.98**	**18%**	**21%**

Xie et al. brought evidence that patients infected with COVID-19 show an increased risk of cardiovascular disease, even after the first 30 days of infection. The risks include cardiovascular diseases, including cerebrovascular disorders, dysrhythmias, myocarditis, ischemic heart disease, heart failure and thromboembolic disease [8].

A significant increase in the incidence of myocarditis was observed among non-hospitalized patients at 12-month follow-up, according to Wang et al. This could have been caused by the absence of proper antiviral and anti-inflammatory treatment [9].

The NACVI study revealed that more than half of COVID-19 patients with STEMI developed different stages of heart failure. Also, COVID-19 patients presented an increased incidence of cardiac arrest and cardiogenic shock.

Patients with COVID-19 pneumonia develop twice as frequent major acute cardiovascular events (MACE), even at the 12-month follow-up (HR = 1.87), with an HR of 1.64 in cardiovascular death. In the NACVI registry, 36% of STEMI patients with COVID-19 presented a further acute cardiovascular event.

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