The experience of treating patients with acute myocardial infarction under the COVID-19 epidemic

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Abstract
Worldwide Coronavirus Disease 2019 (COVID-19) epidemic makes the management of acute myocardial infarction (AMI) more complicated, effective treatment without further dissemination is thus quite challenging. Recently, we successfully treated three representative AMI cases, by sharing these detailed procedures, we summarized some important issues including patient screening, reperfusion strategy selecting, personnel/catheter lab protection principle, as well as operation tactics, which may lend precious experience on AMI treating during the ongoing COVID-19 pandemic situation.

KEYWORDS
acute myocardial infarction, COVID-19, pandemic, percutaneous coronary intervention, personnel protection equipment

1 | INTRODUCTION

The COVID-19 is a widespread disease mainly involving the respiratory system that broke out since December 2019 and infected almost 200,000 people worldwide, resulting in a pandemics situation. It is highly infective, has long incubation period, presents with relatively mild symptoms mostly, and even can be transmitted by asymptomatic patients. Thus, any inappropriate medical behavior, especially an invasive procedure, may result in further dissemination amongst healthcare professionals. All these events result in hardship in the routine management of patients with AMI, a condition highly prevalent during the winter season. Thus, safe, effective, and timely management of this subset of patients in Wuhan, the most seriously affected area, became really challenging. Recently, our team successfully treated three patients presenting with AMI in this epidemic area and now report below.

2 | CASE SERIES

Case 1: A 62-year-old man, residing in Wuhan, came to the emergency department (ED) with the complaint of sudden chest pain for 4 hrs, no history of hypertension, diabetes or dyslipidemia was reported. Electrocardiogram (ECG) revealed ST-segments elevations (>0.2 mV) in leads II, III, aVF, and a diagnosis of inferior wall AMI was made. No fever or respiratory symptoms such as cough or dyspnea was complained, no history of close contact with COVID-19 patients was reported. The lymphocyte count was normal and chest computed tomography (CT) did not reveal any findings suggestive of viral pneumonia. Thus, a fibrinolytic therapy in the form of bolus intravenous (IV) infusion of enoxaprin (30 mg) followed by recombinant tissue plasminogen activator (r-tPA, 50 mg) IV within 90 min was immediately initiated. The door-to-needle time was 95 min. Following this, the patient was transferred to an isolation ward for further monitoring and treatment. Within 2 hrs after administering r-tPA, a complete relief of chest pain was reported coupled with >50% resolutions in ST-segments on the ECG, indicating the restoration of myocardial blood flow (Figure 1). The virus antibodies were tested twice and were both negative. The patient was discharged 7 days later and no chest pain or recurrent ischemic event was complained. The coronary angiography (CAG) was not performed but was advised when the epidemic was over. All these medical activities were completed under the second-level protection.
Case 2: A 42-year-old man, resident of Wuhan, was admitted to our ward with complaints of fever, dry cough, and shortness of breath for the past 1 month. Moisture rales were detected on bottoms of both lungs. Histories of hypertension, diabetes were recorded. Decreased blood lymphocytes counts were found three times before admission. The principal findings on chest CT were fibrinous and focal exudative changes, suggestive of viral pneumonia (Figure 2). Coupled with the history, a clinical diagnosis of COVID-19 was reached. Twenty days prior to this admission, he had undergone a primary percutaneous coronary intervention (PCI) for an anterior AMI, and a drug eluting stent (DES) was implanted in the proximal segment of the left anterior descending (LAD) artery and was already on the antiplatelet, lipid-lowering, and antiremodeling therapies. On Day 3 of this admission, the patient complained of sudden chest pain again and ECG demonstrated elevations of ST-segments in V1-V5 leads, suggesting a reinfarction on anterior wall. Fibrinolytic therapy was not administered, and shortly, the signs of cardiac shock, such as decreased blood pressure (BP) and clamminess in extremities were observed. IV isoprenaline (0.5 μg/min/kg) alone was unable to stabilize the hemodynamics, and the venous–arterial extracorporeal membrane oxygenation (V-A ECMO) and intra-aortic balloon pump (IABP) were applied. The patient was then transferred to an isolated catheter lab, and the CAG was performed, revealing a thrombus totally occluding the stent in LAD, and the chronic total occlusions (CTOs) in the proximal segments of the circumflex branch and right coronary artery. The blood supply restored after the guide-wire being advanced through the occluded segment of LAD, and dilation of the lesion with a 2.0 × 20 mm predilating balloon. Thereafter, an intravenous ultrasound (IVUS) was performed and a dissection distal to the stent in LAD was detected, which might account for thrombotic event. Two additional DESs were then employed in the middle of the LAD followed by post-dilation under IVUS guidance. The complaint of chest pain was relieved, and the dose of IV isoprenaline was down-titrated to 0.01 μg/min/kg. The V-A ECMO was removed 2 days following PCI, and the patient was transferred out of the intensive care unit to an isolated general ward for further management and monitoring. The transfer was under the second-level protection, while PCI was completed under the third-level protection.

Case 3: A 78-year-old man, living in Wuhan, came to the ED with complaint of sudden chest pain for 5 hrs. A history of hypertension

**FIGURE 1** Case 1: (a) ECG before fibrinolysis, the ST-segments elevated in II, III, aVF leads, indicating an inferior wall AMI. (b) ECG of 2 hrs after fibrinolysis, showing a > 50% resolutions of ST-segments in II, III, and aVF leads, indicating the restoration of blood flow.
was recorded. On ECG, ST-segments elevations were detected in V1-V6 (>0.2 mV), I, aVL (>0.1 mV) leads (Figure 3), and anterior wall AMI was diagnosed. There were no complaints of fever or cough, and no history of close contact with COVID-19 patient. A normal lymphocyte count and chest CT made the COVID-19 unlikely. The patient was transferred to an isolated catheter lab immediately, and CAG was performed. The CAG revealed an occluded ostium of LAD and a thrombus could be seen, while the other two vessels were intact. After a guidewire was advanced through occluded segment, the culprit lesion was dilated with a 2.5 × 20 mm predilation balloon, and two DESs were then implanted at the proximal segment of LAD. After an intra-coronary injection of 0.75 mg tirofiban, a TIMI 3 blood flow was finally achieved. The total door-to-balloon time was 139 min. The patient was then transferred to an isolated general ward for further management and monitoring. The level of protection was same as that of Case 2.

3 | DISCUSSION

Timely reperfusion of the affected myocardial tissue is fundamental in the management of patients with ST-segment elevated myocardial infarction (STEMI). However, the dissemination of COVID-19 has severely disturbed the normally followed reperfusion strategy. Thus, the Chinese Society of Cardiology has come up with the consensus statement regarding the procedures of the cardiovascular (CV) emergencies, trying to save the patients with severe CV disorders (CVDs), while avoiding the dissemination of COVID-19 at the same time. Conservative approach may be first choice, but for some critical patients, invasive procedures can also be safely performed, but certain measures must be stressed.

First of all is to screen the COVID-19 by enquiring the history of residence/travel in epidemic areas, or close contact with COVID-19.
patient, as well as the symptoms such as fever, cough; gathering laboratory findings including white blood cell/lymphocytes count, chest CT image; and finally, an etiologic evidence of virus nucleic acid test from the oropharyngeal swabs and/or antibodies (IgM/IgG) from blood sample. All this information should be collected as soon as possible, and then reperfusion strategy can be made and protection level could be stratified.

To avoid the possible cross-infection, a conservative strategy was principally preferred, but an invasive strategy sometimes became mandatory. Thus, the benefit/risk ratio of either approach should be weighed carefully. For a STEMI patient with low bleeding risk, shorter ischemic time, relative less or less important myocardium (e.g., inferior wall) involved, the fibrinolytic therapy with third generation of fibrinolytic agent may be preferred. On the contrary, for elderly, patients with massive myocardium in jeopardy, longer ischemic time, or not satisfactorily reperfusion conservatively, resulting in recurrent ischemic events and/or electric/hemodynamic instability, the invasive strategy is strongly indicated. Complying with this principle, rt-PA was administered in case 1, and a satisfactory result was achieved. Case 2 suffered from a re-infarction with a massive cardiomyocyte involvement, and the failure of timely fibrinolysis led to hemodynamic instability, which made an invasive procedure the best choice, even though he was clinically diagnosed as COVID-19. Case 3 was an elderly diagnosed as extensive anterior AMI, considering the increased bleeding risk and a relatively longer patient-related delay, which would result in decreased success rate, an invasive procedure was finally chosen.
Finally, it should be noted that the epidemic induced delay (for COVID-19 screening) might prolong the door-to-needle/balloon time significantly.

All the patients requiring an invasive procedure were reported to the hospital for record. Complying with the guidelines for prevention and control COVID-19 in hospitals, the catheter lab and all the passages were redesigned and reconstructed, including creating a transition zone between the procedure room and control room. The ventilation system was shut down, and all the ventilating outlets were sealed. Moreover, organizing a team with as less as possible members can further minimize the risk of cross infection. The procedure could be carried out only after all the processes were finished. The medical staff attending the procedure must be at least with a second-level protection, namely equipped with N95 respirators and surgical masks, protective eye wears, face shields, disposable caps(2 layers, covering both ears), gowns and personnel protective equipment(PPE) gowns, two layers of surgical gloves and shoe covers; while during the PCI, besides the sterile gowns outside the leads apron and sterile gloves, the protection level was upgraded to third level: the face shield was replaced by a full face mask in case of a possible blood splash. Moreover, a surgical mask was also worn on the patient’s face to minimize the infectious risk. All staff should be isolated thereafter at least 14 days, the body temperature and any discomfort that caused by COVID-19 should be reported daily.

The tactics adopted in PCI were also important. All the procedures were carried out under full protection, and the visual field and tactile feeling were severely affected. Thus, the manipulations requiring highly fine techniques might not only increase the operative risk, but also the risk of transmission of COVID-19 to the medical staff involved in the process. Thus, PCI only on the culprit lesion is the principle rule and any attempt on complex lesion or additional procedure should generally be avoided. However, in Case 2, in order to identify the underlying cause of the sub-acute thrombosis, and ultimately avoid another possible ischemic event, IVUS was used despite all the obstacles, and reached an optimal final result.

CONCLUSIONS

Managing an AMI during the epidemic is challenging. Preventing the dissemination of COVID-19 amongst the healthcare workers is the priority, and a conservative strategy is often the first choice. However, in patients strongly indicated for an invasive strategy mentioned above, PCI should be performed after weighing the benefit/risk ratio carefully. As long as the procedures are strictly followed, and most important, the protection is stratified and guaranteed, an optimal result can be anticipated. The successful management of these three cases mentioned above not only resulted in an improved patient prognosis, but also brought precious experience on how to handle cardiovascular emergencies properly, especially under such a serious epidemic situation.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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