Safety measures for COVID-19 do not compromise the outcomes of patients undergoing primary percutaneous coronary intervention: A single center study

Xiaonan Guan
Center of Cardiology, Beijing Chaoyang Hospital, Capital Medical University
Jianjun Zhang (d2212343@163.com)
Center of Cardiology, Beijing Chaoyang Hospital, Capital Medical University
Yanbing Li
Center of Cardiology, Beijing Chaoyang Hospital, Capital Medical University
Ning Ma
Center of Cardiology, Beijing Chaoyang Hospital, Capital Medical University

Research Article

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Abstract

Coronavirus disease 2019 (COVID-19) is a global pandemic impacting nearly 170 countries/regions and millions of patients worldwide. Patients with acute myocardial infarction (AMI) still need to be treated at percutaneous coronary intervention (PCI) centers with relevant safety measures. This study was conducted to assess the therapeutic outcomes of PCI performed under the safety measures and normal conditions. AMI patients undergoing PCI between January 24 to April 30, 2020 were performed under safety measures for COVID-19. Patients received pulmonary computed tomography (CT) and underwent PCI in negative pressure ICU. Cardiac catheterization laboratory (CCL) staff and physicians worked with level personal protection. Demographic and clinical data, such as door-to-balloon (DTB) time, operation time, complications for patients in this period (NCP group) and the same period in 2019 (2019 group) were retrieved and analyzed. NCP and 2019 groups had 37 and 96 patients, respectively. There was no significant difference in age, gender, BMI and comorbidity between the two groups. DTB time and operation time were similar between the two groups (60.0 ± 12.39 vs 58.83 ± 12.85 min, $p = 0.636$; 61.46 ± 9.91 vs 62.55 ± 10.72 min, $p = 0.592$). Hospital stay time in NCP group was significantly shorter (6.78 ± 2.14 vs 8.85 ± 2.64 days, $p < 0.001$). The incidences of malignant arrhythmia and Takotsubo Syndrome in NCP group were higher than 2019 group significantly (16.22% vs 5.21%, $p = 0.039$; 10.81% vs 1.04% $p = 0.008$). During hospitalization and 3-month follow-up, the incidence of major adverse cardiovascular events and mortality in the two groups were statistically similar (35.13% vs 14.58%, $p = 0.094$; 16.22% vs 8.33%, $p = 0.184$). Our analysis showed that safety measures undertaken in this hospital, including screening of COVID-19 infection and use of personal protection equipment for conducting PCI did not compromise the surgical outcome as compared with PCI under normal condition, although there were slight increases in incidence of malignant arrhythmia and Takotsubo Syndrome.

Introduction

Novel coronavirus pneumonia (NCP) spread rapidly from Wuhan to most regions of China after December 2019 [1]. As of September 5, 2020, 85122 confirmed cases were reported in China. In addition, a total of 818580 close contacts were traced during last 10 months and 6110 close contacts are still under medical observation. Because of the strong infectivity of the SARS-nCov-2 that causes *COVID*-19, the operation and treatment in many medical institutions were affected [2]. During this time, elective percutaneous coronary intervention (PCI) was cancelled or postponed in the hospital and only emergency PCI was allowed to proceed. In order to ensure safety of patients and medical staff, our hospital applied relevant procedures for admission and surgical management for PCI patients with acute myocardial infarction (AMI).

The study was conducted to compare the therapeutic outcomes of patients who underwent PCI under the safety procedure in 2020 and normal condition in 2019, and the findings would help to develop and use of COVIS-19 safety procedures in other hospitals for timely treatment of AMI patients.

Subject And Methods

Subjects

AMI patients who received emergency PCI between January 24 and April 30, 2019 and 2020 were included in this retrospective study as 2019 and NCP groups. All patients received 300 mg aspirin and 180 mg ticagrelor before operation. Demographic and clinical data of patients, such as door-to-balloon (DTB) time, operation time and complications were retrieved from hospital medical databases. Patients were diagnosed AMI based on electrocardiogram (ECG) and/or cardiac enzyme profiles using the fourth universal definition of myocardial infarction [3]. Hypertension, diabetes and dyslipidemia were diagnosed based on relevant guidelines [4-6]. Cardiogenic shock was established if there was persistent hypotension (SBP <90 mmHg) despite adequate filling status with signs of hypoperfusion [7]. Patients were considered to have heart failure if the Killip class was > I.

Safety measures for COVID-19

Four personal protective levels were set up: general protection with surgical masks, level □ protection requiring to wear work clothes, work caps, surgical masks and gloves, level □ protection requiring to wear work clothes, work caps, isolation gowns, shoe covers, medical protective masks, goggles or protective face screen and level □ protection requiring to wear N95 masks and double layer gloves in addition to level II protections. According to exposure risks, the hospital was divided into three areas that implemented different levels of protection. “Red area” was designated for high risk areas such as fever clinic, emergency department, laboratory, pathology department, intensive care unit and other departments that might be directly in contact with patients who had not been tested for SARS-nCov-2 nucleic acid. The protection for the red area was level □. “Yellow area" was designed as a buffer area for coronary care unit (CCU). The yellow area ward was a separate nursing unit in the hospital, and each room only accommodated one emergency patient. The protection in the yellow area was "level □ ". "Green area" was designated for general cardiology ward. Patients were transferred to the area after nucleic acid test was done, the result was negative and the isolation period was over. For this area, the protection was level □.

Primary PCI procedure for NCP group

While patients in 2019 group were treated as usual, the patients in NCP group were requested to wear a surgical mask in all areas as general protection. Within 30 min after arriving at emergency department, patients were examined for epidemiological history, symptoms such as fever and cough, chest CT and routine blood tests. Patients with epidemiological history and symptoms such as fever and cough were routed to negative pressure cardiac catheterization laboratory (CCL) for PCI. During PCI, the results of chest CT and routine blood tests were assessed by a five-person expert panel to determine if the patients from regular CCL should be sent to yellow area or to negative pressure CCL. Patients routed to isolation ward or negative pressure ICU were transferred to the buffer ward after medical isolation observation (usually for a week) and negative nucleic acid detection [8]. Other patients (without symptoms and epidemiological history) were sent to regular CCL for PCI after consultation with NCP expert panel

(composed of respiratory department, radiology department, intensive care unit, infection department and emergency department). After the operation, the patients were transferred to the buffer ward (yellow area) for COVID-19 test and isolation observation. After coronavirus infection was completely excluded, patients were allowed to stay in the green area in department of cardiology (Figure 1).

Statistical analysis

The normality of distribution of continuous variables was tested by one-sample Kolmogorov-Smirnov test. Continuous variables with normal distribution were presented as mean ± standard deviation and analyzed using Student's *t*-test. Categorical variables are presented as percentage, and analyzed using $\chi 2$ test Fisher's exact test, when appropriate. A value of $P < 0.05$ was considered significant. SPSS version 25.0 for Windows (SPSS Inc., Chicago, IL, USA) was used to analysis all data.

Results

A total of 37 and 96 AMI patients undergoing primary PCI between January 24 and April 30, 2020 and 2019 were included in this study (Table 1). The age and BMI in NCP group and 2019 group were 59.70 ± 13.76 vs. 58.60 ± 11.19, and 26.64 ± 4.68 vs. 25.63 ± 4.16, respectively. There was no significant difference in age, gender, BMI and comorbidity between the two groups. There was no significant difference in hypertension, diabetes, hyperlipidemia and smoking between the two groups. Drug eluting stent (DES) were implanted in 27 (72.97%) patients in NCP group and 79 (79.17%) patients in 2019 group ($P > 0.05$). Six (16.22%) patients in NCP group and 19 (19.76%) patients in 2019 group received percutaneous transluminal coronary angioplasty (PTCA, $P > 0.05$). DTB time and operation time of NCP and 2019 groups were similar (60.0 ± 12.39 vs 58.83 ± 12.85 m, $p = 0.636$; 61.46 ± 9.91 vs 62.55 ± 10.72 m, $p = 0.592$) (Figure 2). Four patients in NCP group were diagnosed as having Takotsubo Syndrome (TTS). The incidence was significantly higher than that in the 2019 group (10.81% vs 1.04%, $p = 0.008$). Three of them were women aged 60-81 with apical TTTS, and the other was man aged 55 with focal TTS (Figure 3 and 4). However, coronary angiography showed no severe stenosis in all 4 patients. The hospital stay time in NCP group was significantly shorter than in 2019 group (6.78 ± 2.14 vs 8.85 ± 2.64 days, $p < 0.001$) (Figure 2). There was no significant difference between the two groups in incidence of cardiogenic shock, heart failure and death during hospital (Figure 5). However, the incidence of malignant arrhythmia was significantly higher than in NCP group than 2019 group (16.22% vs 5.21%, $p = 0.039$).

The patients were followed up for 3 months. During the follow-up, there was no difference in re-hospitalization rates due to heart failure and acute coronary syndrome (ACS) and mortality between the two group (Figure 5). The incidence of major adverse cardiac events (MACE) was also not statistically different between the two groups (Table 2)

Discussion

According to the new coronavirus china guidelines [9], this hospital developed safety measures and procedures for COVID-19 such as zoned areas and different levels of protection. With these measures and procedures, AMI patients were timely treated with PCI even during the *COVID-19 pandemic*. In the procedures the risk level was determined based on information and experience from Wuhan and the virus was believed to mainly transmitted by droplets, feces, urine, and even aerosols [10]. Considering the closed environment of the CCL and the uncertainty of whether the patients are infected, the procedures required that the PCI team uses level protection and the CCL was designated as red area for the highest safety. PCI Patients with epidemiological history and respiratory symptoms such as fever and asthma are allocated to isolation ward or negative pressure ICU after operation. No patients were not allowed to gain direct access to the green area from the red area to prevent potential infection. In addition, patients were examined using blood tests and pulmonary CT as a fast way to rule out the possibility of infection. To implement the procedures, a team of experienced experts were in place 24 h a day, seven days a week to interpret the epidemiological data, pulmonary CT and routine blood tests to identify suspected NCP infection. As a consequence of the collective efforts, no patients and hospital staff in the cardiology department are infected with *COVID-19.* To assess the possible impact of the safety measures on the outcomes of PCI, we compared the clinical outcomes of NCP group with 2019 group, which was performed under normal condition. Compared with 2019, only emergency and fever patients came to the hospital for treatment in 2020, leading to fewer patients. Although these patients were subjected to a series of additional screening and examinations prior to the surgery as compared with 2019, the DTB time was similar between the two groups. This might be due to reduced number of patients, which allowed faster handling and treatment by the medical team. Also, it indicated that wearing level **III** protection may not affect the operation time. The hospitalization time of patients in NCP group was significantly shorter than 2019 group. This may be because during the NCP, patients were encouraged to leave the hospital as soon as possible to avoid possible infection risk of the virus. During the 3-month follow-up, there was no significant difference in readmission rate and mortality between the two groups. However, it is worth noting that the incidence of malignant arrhythmia was somewhat higher in NCP group, which could post potential risk to patients. Malignant arrhythmia may be related to sympathetic excitation caused by tension, but it is unclear why its incidence is higher in the NCP group. Another finding is that the incidence of TTS is higher in the NCP group. TTS is estimated to represent approximately 1– 3% [11,12] of all and 5–6% [13] of female patients presenting with suspected STEMI. Sympathetic stimulation is considered one of the major pathophysiological mechanisms of TTS [14]. The novel coronavirus pneumonia is stressful, which would make people panic and trigger dramatic emotional change. This may attribute to the increased incidence of TTS. Catecholamine storm leads to malignant arrhythmia in TTS [15] and AMI[16]. Therefore, beta blockers may be considered to treat malignant arrhythmia during this period.

Ischemic heart disease is the single most common cause of death in the world. Primary PCI is the preferred reperfusion strategy in patients with STEMI within 12h of symptom onset. For better outcomes, DTB time should be controlled within 90 minutes[17]. The mortality in STEMI patients is influenced by many factors. Patients with cardiovascular disease who develop COVID-19 may have a higher risk of

mortality[18]. This is similar to the situation with acute respiratory syndrome coronavirus (SARS-CoV)[19] and the Middle East respiratory syndrome coronavirus (MERS-CoV)[20]. How COVID-19 is associated with cardiovascular (CV) injury is not clear. Possible mechanisms include viral myocarditis, ACE-2 receptor-mediated CV injury, microvascular dysfunction and cytokine release syndrome[21,22]. ACC/AHA Management of AMI During the COVID-19 Pandemic suggests that primary PCI remains as standard of care for STEMI patients at PCI capable hospitals when it can be provided in a timely fashion, with an expert team outfitted with PPE in a dedicated CCL room [23]. Our experience demonstrates that primary PCI can be performed during the COVID-19 pandemic to obtain therapeutic outcomes comparable to these obtained in normal condition.

Because COVID-19 is infectious in the latent period, and are more infectious within 5 days after the onset of the disease [24], and patients cannot be excluded for infection in a short time, it is important to separate infected patients from uninfected patients in the treatment process. AMI patients often suffer from severe chest pain and are at risk of hemodynamic collapse, and it is difficult for them to wait for COVID-19 test result even from rapid nucleic acid assay. Therefore, the clinical conditions of patients should be assessed safely and rapidly to allow timely treatment.

There are limitations in our study. First of all, due to the pandemic situation, the number of AMI patients was small, which may lead to bias in the results. Secondly, the follow-up time was short. Finally, due to the nature of the pandemic, the severity of infection in Beijing was not able to compare with other regions, which may impact the representativeness of our study.

Conclusion

The safety measures and procedures established in our hospital resulted in no COVID-19 infection of patients and medical staff in the cardiology department during the NCP epidemic period, and also allowed timely implementation of primary PCI for AMI patients. Compared with PCI performed under normal conditions, PCI performed with the safety measures and procedures did not increase DTB time, and the therapeutic outcomes are comparable with those obtained in normal conditions, although the incidences of malignant arrhythmia and TTS are higher.

Declarations

Ethics approval: This study was approved by the Ethical Committee of Capital Medical University, China. Written and informed consents were obtained from all patients.

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Availability of data and material: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of interest: None.

Author contributions: Authors' contributions: XG and JZ and deigned study. XG, JZ, YL and NM performed diagnosis and treatment. JZ, YL and NM performed the statistics analysis. XG, JZ, YL and NM drafted the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1. Patient characteristics

	NCP group (n=37)	2019 group (n=96)	T/χ^2	*P*
Age, y	59.70±13.76	58.60±11.19	0.475	0.636
BMI, kg/m^2	26.64±4.68	25.63±4.16	1.215	0.227
Male, n (%)	26 (70.27)	71 (73.96)	0.184	0.668
Hypertension, n (%)	23 (62.16)	58 (60.42)	0.034	0.853
Diabetes, n (%)	19 (51.35)	49 (52.04)	0.001	0.974
Hyperlipidemia, n (%)	25 (67.57)	53 (55.21)	1.682	0.195
Smoke, n (%)	21 (56.76)	56 (58.33)	0.027	0.869
DTB, min	60.0±12.39	58.83±12.85	0.474	0.636
Operation time, min	61.46±9.91	62.55±10.72	-.0.538	0.592
Drug eluting stent, n (%)	27 (72.97)	76 (79.17)	0.151	0.698
Stent number	1.05±0.82	1.10±0.80	-0.322	0.748
PTCA, n (%)	6 (16.22)	19 (19.76)	0.224	0.636
Takotsubo Syndrome, n (%)	4 (10.81)	1 (1.04)	7.045	0.008
Hospital stay, day	6.78±2.14	8.85±2.64	-4.255	<0.001
Cardiogenic shock, n (%)	3 (8.11)	4 (4.17)	0.832	0.362
Malignant arrhythmias, n (%)	6 (16.22)	5 (5.21)	4.266	0.039
Heart failure, n (%)	2 (5.41)	10 (10.42)	0.817	0.366
Death, n (%)	4 (10.81)	6 (6.25)	0.799	0.371

Table 2. Major adverse cardiac events in three-month follow-up

	NCP group (n=37)	2019 group (n=96)	χ^2	P
Major adverse cardiac events, n (%)	10 (35.13)	14 (14.58)	2.796	0.094
Re-hospitalization for heart failure, n (%)	3 (8.11)	4 (4.17)	0.832	0.362
Re-hospitalization for ACS, n (%)	1 (2.7)	2 (2.08)		1.000
Death, n (%)	6 (16.22)	8 (8.33)	1.762	0.184