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Successful percutaneous coronary intervention with extracorporeal membrane oxygenation for patient with acute coronary syndrome and cardiac arrest: a case report

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Abstract. – BACKGROUND: The incidence rate of acute coronary syndrome (ACS) in China is on the rise and is considered a leading cause of death. Emergency percutaneous coronary intervention (PCI) is the preferred treatment method for ACS. However, severe complications may hinder emergency PCI and lead to increased mortality. Extracorporeal membrane oxygenation (ECMO) redirects blood flow and oxygenates it before returning. Therefore, ECMO support during PCI may improve functional recovery and outcomes. This case report presents a successful case of extracorporeal membrane oxygenation (ECMO)-assisted emergency PCI treatment of an outpatient with ACS.

CASE REPORT: Male, 43 years old, experienced sudden, severe, and persistent squeezing-like chest pains accompanied by profuse sweating. After half an hour, the patient suddenly lost consciousness and was unable to exhale. After ECMO-assisted PCI, the patient's blood pressure and blood oxygen status improved, and the autonomous rhythm was restored. Imaging results showed 100% occlusion of the middle to distal anterior descending branch. After undergoing distal thrombus aspiration, a stent was implanted in the proximal end of the anterior descending branch. Repeated angiography showed good stent adhesion and restored blood flow in the anterior descending branch. The postoperative patient was transferred to the coronary care unit (CCU) ward with ECMO and ventilator for monitoring.

CONCLUSIONS: ECMO-assisted emergency PCI effectively improved the blood pressure and oxygen status of the ACS patient with cardiac arrest, and restored the autonomous rhythm, with a good rehabilitation effect.

Key Words:

Percutaneous coronary intervention, Extracorporeal membrane oxygenation, Acute coronary syndrome.

Background

Acute coronary syndrome (ACS) is caused by thrombosis and the rupture or erosion of the unstable atherosclerotic plaque in the coronary artery. The definition of ACS includes ST-elevation myocardial infarction (STEMI), non-ST elevation myocardial infarction (NSTEMI), and unstable angina (UA)[1,2].

The incidence rate of ACS is currently on the rise. According to the China Cardiovascular Health and Disease Report 2020[3], ACS is considered a leading cause of death and shows an increasing trend in the younger population. Emergency percutaneous coronary intervention (PCI) is currently the preferred non-surgical method for treating ACS[4]. However, in cases of cardiac arrest, the implementation of PCI becomes difficult and the perioperative mortality rates are high. Previous reports[5] showed that extracorporeal membrane oxygenation (ECMO) can improve the efficiency of PCI in patients with cardiac arrest. Interventional catheterization room nurses participate in every stage of the management of emergency PCI patients and play a crucial role in emergency situations such as sudden complications during surgery. With the continuous development and improvement of collaboration between chest pain centers, pre-hospital emergency transportation, emergency department, and heart center departments, treatment and diagnosis of acute myocardial infarction patients become more timely, standardized, and efficient. This study reports a successful case of ECMO-assisted emergency PCI treatment for an outpatient with ACS and cardiac arrest in the first hospital of Lanzhou University in 2022. Written informed consent was obtained from the patient for publication of this case report.

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Case Presentation

Clinical Data

Basic information

The patient was a 43-year-old male with a height of 172 cm and a weight of 65 kg, with no special or personal history of heart disease. At 12:20 on December 14th, the patient experienced sudden squeezing-like pain in the chest, which was severe and persisted without relief, accompanied by profuse sweating. Half an hour later, the patient suddenly lost consciousness and became irresponsive. The patient's family contacted the emergency team, and the bedside cardiopulmonary resuscitation was started first under the guidance of the medical staff.

Receiving and transferring

At 12:50 pm on December 14, 2021, the Gansu Emergency Medical Rescue Center quickly arrived at the scene and initiated cardio-pulmonary resuscitation (CPR) and tracheal intubation after witnesses at the scene called for emergency care. The on-site electrocardiogram was uploaded to the pre-hospital treatment network WeChat group for acute myocardial infarction, and all departments of the chest pain center were activated immediately, while the patient was being transported to the emergency department. The cardiac rhythm of the patient at arrival showed ventricular fibrillation/tachycardia, with loss of consciousness and undetectable blood pressure. At 13:48 pm, ECMO was immediately established, and local cooling was given to the headrest using ice packs. After ECMO artificial membrane lung assistance, the patient's blood pressure and blood oxygen status improved, and the autonomous rhythm was restored.

Coronary artery reperfusion

Implanting a cardiac stent to open the diseased blood vessel is the preferred measure for treating ACS patients when the patients are within the time window of PCI coronary artery opening. Sixteen hours after admission, the cardiology catheterization room initiated an emergency plan and opened the PCI green channel for the catheterization room. The patient was transferred to the cardiac catheterization room, and the medical staff immediately began emergency coronary angiography with the assistance of ECMO. The angiography results showed that the middle to distal segments of the anterior descending branch were 100% occluded. After undergoing distal thrombus aspiration, a stent was implanted in the proximal end of the anterior descending branch. Repeated angiography showed good stent adhesion and restored blood flow in the anterior descending branch. During the operation, the patient experienced multiple episodes of ventricular fibrillation during the surgery and was given electric defibrillation once without sinus conversion. With ECMO assistance, the blood pressure was maintained at 61/60 (62) mmHg, and ventilator-assisted breathing was used. Blood oxygen saturation was maintained at over 85% during the surgery. The bedside heart color ultrasound showed that the ejection fraction (EF) of the patient was only 24%, and the bilateral pupils were 2 mm. Breathing sound in both lungs was thick, and the heart valve was free of murmur. Considering the critical condition of the patient, he was transferred to the CCU ward postoperatively, with ECMO and ventilator for monitoring. Any changes in electrocardiogram and blood pressure were closely monitored. Based on the doctor's advice, the patient was administered 3 mg of morphine intravenously to alleviate pain.

Subsequent treatment and outcome

During postoperative monitoring, the ECMO machine operated normally, with a flow rate of 2.0-2.5 L/min, a heart rate of 70-85 pbm, and a blood pressure of 100-115/60-70 mmHg. On the third day after the surgery, ECMO was disconnected after a comprehensive evaluation. Arterial blood gas pH was 7.51, pO_2 was 100 mmHg, pCO_2 was 36 mmHg, Lac was 0.6 mmol/L. Cardiac ultrasound showed EF of 0.46, left ventricular end-diastolic volume (LVEDV) 93 ml, left ventricular end-systolic volume (LVESV) 50 ml, CO 3.4L/min, left atrial diameter increased, left ventricular wall motion amplitude decreased, left ventricular systolic and diastolic function decreased, mitral/Tricuspid valve slightly regurgitated, and pulmonary artery pressure was normal. After a comprehensive evaluation, the ventilator was withdrawn, and the patient was provided with high-flow oxygen for rehabilitation treatment. After 14 days of monitoring, the patient was transferred to a regular ward. Curative care of the primary disease was done simultaneously with measures to relieve the physical discomfort caused by the disease. Nursing operations and treatment were carried out in a centralized manner, with minimal disruption to the patient's sleep. On January 3, 2022, the patient was given corresponding diet, exercise, and psychological

counseling upon discharge. The patient was followed up for three months after discharge, and his cardiac function recovered well.

Discussion

The patient involved in this study had a cardiac arrest before being admitted to the hospital, and the electrocardiogram confirmed the presence of ventricular fibrillation. Ventricular fibrillation in acute myocardial infarction may be related to acute coronary artery occlusion, myocardial ischemia, and myocardial electrical activity disorder[6]. Ventricular fibrillation occurs in 7-8% of acute myocardial infarction. Malignant arrhythmia is often associated with cardiogenic shock, a high mortality rate (70-80%)[7]. Rapid revascularization and restoration of blood perfusion are crucial and can improve malignant arrhythmia[6,7]. Studies[6-8] show that patients with recurrent malignant arrhythmia and hemodynamic instability after routine cardiopulmonary resuscitation and advanced life support treatment for cardiac arrest may benefit from extracorporeal life support, such as ECMO.

During the ECMO procedure, a portion of blood (approximately 50% of the patient's normal cardiac output) is extracted from the venous system through a centrifugal pump, oxygenated, and then transfused back into the patient's arterial system, effectively replacing the pump function of the patient's own heart and maintaining circulatory function[9]. By reducing venous blood flow, ECMO reduces cardiac preload, cardiac burden, myocardial oxygen consumption, and myocardial injury, and promotes the recovery of myocardial function[10-12]. Maintaining stable circulation ensures that the use of vasodilators is safe, which in turn reduces cardiac afterload[13]. Thus, ECMO may improve hemodynamics during PCI and increase the heart's tolerance to surgical trauma[14]. In case of severe complications such as ventricular fibrillation, respiratory, cardiac arrest, cardiac tamponade, etc., during the operation, full flow perfusion can be immediately changed to completely replace cardiopulmonary function, maintain effective circulation and oxygen supply, win time for further rescue attempts, and reduce the risk during PCI[11,13,14]. In our case report, the patient had a sudden cardiac and respiratory arrest before the surgery. Timely stable perfusion flow provided by ECMO helped to stabilize the patient's hemodynamics during the coronary artery surgery.

The timing of ECMO establishment is a key factor determining the success or failure of ECMO[10,11]. In cases of delayed ECMO support, death may occur due to the inability to recover the function of organs such as the brain, liver, and kidneys, even if the cardiopulmonary function is restored[10,11,13]. Therefore, we recommend establishing ECMO assistance before PCI and using it throughout the entire surgical process, rather than using ECMO rescue only when problems arise during PCI[11,13,14].

The increasing level of diagnostic and treatment technology in cardiac emergencies has put forward higher standardized requirements for the professional competence of interventional surgery nursing personnel[15]. In this regard, targeted training of nursing personnel should include training in clinical nursing thinking, basic specialized skills, daily drills of emergency plans, and discussion and analysis of special cases, to better integrate theory with practice. Catheter room nurses should constantly update their specialized knowledge, improve their professional competence, and ensure close cooperation with different cardiac intervention surgery teams.

The present study confirms that ECMO plays an important role in stabilizing hemodynamics and shows that the application of ECMO during PCI can provide cardiopulmonary support to patients with ACS and cardiac arrest. Moreover, it suggests that ECMO should be applied as early as possible. Therefore, PCI with ECMO may become an important approach for the management of patients with ACS and cardiac arrest.

There are some limitations of the study. First, as there is only one case in this study, the generalization of the findings may be limited. Second, the follow-up period is short, and the long-term physical condition of the patient after treatment needs to be studied. In addition, the establishment of ECMO requires specific equipment, higher technical requirements, and higher treatment costs, which makes it less clinically applicable in some regions, and more research is needed to address these issues in future studies.

Conclusions

ECMO-assisted emergency PCI was effective in improving blood pressure, oxygen status and autonomous rhythm of the ACS patient with cardiac arrest, with a good overall rehabilitation effect.

Conflict of Interest
The authors declare that they have no conflict of interests.

Funding
None.

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

Authors' Contribution
ZG conceived and designed the study. ZG and KL collected the data and performed the analysis. ZG was involved in the writing of the manuscript. KL Edited the manuscript. All authors have read and approved the final manuscript.

Ethics Approval
The Ethics Committee of The Lanzhou University First Hospital approved this study (LDYYLL2021-155).

Informed Consent
Written patient consent was received.

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