Electric Shock for a Patient with Ventricular Fibrillation during Air Evacuation Using a Helicopter

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Abstract
A 73-year-old male suddenly felt chest pain and nausea in his home. The fire department requested the dispatch of a physician-staffed helicopter. When the medical staff of the helicopter checked him, his 12-lead electrocardiogram showed ST elevation at the II, III, and aVF leads. After being fitted with pads for monitoring and defibrillation, he was transferred to the helicopter. Before landing at the base hospital a few minutes later, his electrocardiogram suddenly demonstrated ventricular fibrillation (VF). The patient received an electric shock. When the helicopter landed on the base hospital, he still showed VF. After being directly transferred to the catheter room, he received advanced cardiac life support with percutaneous cardiopulmonary support. A trans-arterial coronary angiogram revealed total occlusion of the right coronary artery. After recanalization of the occluded artery, he regained spontaneous circulation. He received intensive care, including targeted temperature management, and he regained consciousness and achieved social rehabilitation. We herein report the first case of VF safely treated with an electric shock during air evacuation by a rotary-wing aircraft in the English literature. Preparations in advance are necessary to perform electric shock safely during a flight aboard rotary-wing aircraft.

Keywords: Air evacuation, electric shock, helicopter

Introduction
Prompt electric shock for a patient with ventricular fibrillation (VF) is essential for obtaining a favorable outcome. The use of an automated external defibrillator (AED) aboard commercial aircraft has shown effectiveness, with an excellent rate of survival to discharge from the hospital after the conversion of VF. However, rotary-wing aircraft, such as helicopters, tend to have relatively little cabin space compared with fixed-wing aircraft and can consequently carry a few passengers. As such, rotary-wing aircraft tend to not be equipped with AEDs or other defibrillators except for medical helicopters.

There has been one report in which AEDs were used to analyze the heart rhythm in a helicopter using a mannequin and a human volunteer. However, there is no English literature concerning the administration of electric shock during air transportation in a helicopter. The physician-staffed helicopter (also known as a doctor helicopter [DH]) in eastern Shizuoka prefecture in Japan routinely performs air evacuation from the scene or inter-hospital transportation for patients with endo- and exogenous diseases, including cardiopulmonary arrest. The crew of the DH generally consists of one pilot, one mechanic, one doctor, and one nurse. The DH is equipped with a manual defibrillator for monitoring and electric shock, and tests are performed in advance to ensure there is no electromagnetic interference.

We herein report a patient with VF who required electric shock during air evacuation in the DH.

Case Report
A 73-year-old male suddenly felt chest pain and nausea with a cold sweat in his home around 10:00 AM. He had a glucose tolerance disorder, and his mother had died of acute myocardial infarction. As his symptoms did not improve, his family...
called an ambulance at 10:46 AM. The content of the first call strongly suggested acute coronary syndrome, and hence the fire department requested the dispatch of the DH before the ambulance reached his home. When emergency medical technicians (EMTs) checked him, he had clear consciousness, and the EMTs performed a 12-lead electrocardiogram. The electrocardiogram showed ST elevation at the II, III, and aVF leads. The patient was transported through ambulance to a rendezvous point where the DH had already landed, with the patient’s information sent in advance. When the medical staff of the DH checked him in the ambulance at 11:16 AM, he had clear consciousness and was complaining of severe chest pain with a cold sweat. His vital signs were as follows: blood pressure, 168/88 mmHg; heart rate, 62 beats/min; respiratory rate, 36 breaths/min; percutaneous saturation, 100% under room air; and body temperature, 35.1°C. He still showed ST elevation in the same leads and ST depression in the precordial leads [Figure 1].

He received nitroglycerin spray and aspirin transorally and morphine and nicardipine intravenously after a venous route was secured. An ultrasound study denied dissection of the ascending aorta. His 12-lead electrocardiogram was directly transmitted using a smartphone video transmission system to our base hospital,[7] and cardiologists in the hospital decided to have the patient transferred directly from the heliport to a coronary catheter room once the DH arrived at the heliport.

The cardiologists also ordered the physician of the DH to infuse 5000 units of heparin into the patient. After being fitted with pads for monitoring and defibrillation, he was transferred to the helicopter. The DH took off from the rendezvous zone at 11:30 AM. His blood pressure was controlled under 140 mmHg using continuous infusion of nicardipine. He became sleepy due to the morphine but responded to questions, and he said that his chest pain had improved, but he still had a tight chest feeling at 11:35 AM, even though his vital signs were stable.

At 11:39 AM, a few minutes before landing at the base hospital, his electrocardiogram suddenly showed VF. After confirmation of a nonresponsive and pulseless state, chest compression, and bag-valve ventilation were initiated. The base hospital was alerted to the sudden cardiac arrest of the patient through wire, and permission to perform electric shock was obtained from the pilot of the DH. The patient received 120 Joules of electric shock at 11:40 AM while the DH was preparing for landing [Figure 2]. However, the VF was not resolved. After receiving word of the sudden collapse of the patient, the cardiologists in the hospital ordered the medical technicians in the coronary catheter room to prepare percutaneous cardiopulmonary support (PCPS). When the DH landed on the rooftop heliport of the base hospital at 11:42 AM, he still showed VF. A second electric shock of 200 Joules was then executed at 11:44 AM, just before the patient was transferred from the DH to the catheter room and just after the rotating helicopter blades had been stopped. The interval that elapsed between the first and second shock was because the flight physician had left the DH (while the blades were still rotating) to explain the patient’s current status to the cardiologist directly. While the VF remained even after the second shock, he showed a return of spontaneous respiration.

After being directly transferred to the catheter room while receiving chest compression and support ventilation, he underwent a third electric shock that was also not effective. He then received tracheal intubation, mechanical ventilation, and an indwelling catheter for the PCPS. The PCPS was started at 12:00 AM, and chest compressions were ceased even though VF persisted. A trans-arterial coronary angiogram revealed total occlusion at mid segment of the right coronary artery [Figure 3]. After the recanalization of the occluded artery, he regained spontaneous circulation. He received intensive care, including targeted temperature management, and he regained consciousness and achieved social rehabilitation.

Figure 1: Twelve leads electrocardiogram at a rendezvous zone. The electrocardiogram shows ST elevation at II, III, and AVF leads, and ST depression in precordial leads 12

Figure 2: Strip of an electrocardiogram when an electric shock is performed. As a patient becomes ventricular fibrillation so that the patient receives electric shock (arrow) during flight by a helicopter
**Discussion**

We herein report the first case of VF safely treating with the electric shock during air evacuation by a rotary-wing aircraft in the English literature. While the patient did not obtain spontaneous circulation by electric shock, he did achieve social rehabilitation through PCPS-assisted cardiopulmonary resuscitation, prompt coronary angioplasty with optimizing door-to-balloon times management and intensive care, including targeted temperature management.\[^{8,9}\]

Several key points must be considered when performing electric shock during transportation using rotary-wing aircraft. First, the presence of electromagnetic interference between the electric shock of the defibrillator and the equipment inside the aircraft must be checked in advance to avoid electronic disturbance during the flight and prevent a crash. Defibrillators that have passed tests of electromagnetic interference should be equipped in helicopters that carry patients who may develop VF. Second, pads for electric shock should be placed into the body of patients at risk of VF before takeoff, as it is difficult and time-consuming to place the pads on a clothed patient laid out on a stretcher with a seatbelt in the narrow helicopter cabin during the flight. Third, space to set the defibrillator during the flight should be secured. In the present case, we placed the defibrillator under the patient’s head by elevating the anterior part of the stretcher; it was set in front of the flight physician to allow them to observe the patient and monitor the defibrillator at the same time and to perform airway management easily when necessary. Finally, information on the patient’s status should be shared between the flight medical staff and the staff at the receiving hospital through appropriate communication tools to ensure the patient receives optimal support after arrival at the hospital.

**Conclusion**

We reported the first case of VF safely being treated with electric shock during air evacuation by a rotary-wing aircraft in the English literature. Preparations in advance are necessary to perform electric shock safely during a flight aboard rotary-wing aircraft.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

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