

## Clinical Communications: Adults

### DOUBLE SIMULTANEOUS DEFIBRILLATORS FOR REFRACTORY VENTRICULAR FIBRILLATION

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□ **Abstract—Background:** Out-of-hospital cardiac arrest is a leading cause of death in the United States. Ventricular fibrillation (VF) is the most common initial rhythm after cardiac arrest. **Objective:** To describe a novel approach to the patient with intractable VF after cardiac arrest. **Case Report:** A 51-year old man presented in cardiac arrest after a ST-elevation myocardial infarction. He remained in VF despite receiving typical therapy including cardiopulmonary resuscitation, amiodarone, lidocaine, epinephrine, and five attempts at defibrillation with 200 J using a biphasic defibrillator. VF was eventually terminated with 400 J by the simultaneous use of two biphasic defibrillators. The patient had a full recovery. **Conclusion:** We present a case and supportive literature for a novel treatment of high-energy defibrillation in a patient with refractory VF. © 2014 Elsevier Inc.

□ **Keywords—**ventricular fibrillation; defibrillation; cardioversion; cardiac arrest; myocardial infarction

#### INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is a major cause of death in the United States affecting nearly 300,000 individuals each year, with a mortality rate of 92% (1,2). It is estimated that 70–85% of OHCA is caused by a primary cardiac etiology (3). Ventricular fibrillation (VF) is the most common initial rhythm after OHCA, occurring in approximately 70% of cases (4–6).

The most recent resuscitation guidelines continue to encourage early defibrillation as the hallmark of treat-

ment for VF, in addition to high-quality cardiopulmonary resuscitation (CPR) (7). Although VF typically responds well to defibrillation, there are cases where a patient will not convert with standard energies. Increased body mass and habitus may hamper the delivery of electricity to the heart. We report a case of intractable VF that did not respond to typical antidysrhythmics and defibrillation. Through the simultaneous use of two biphasic defibrillators, a total of 400 Joules (J) was administered, terminating VF and restoring a perfusing rhythm.

#### CASE REPORT

A 51-year-old man presented to the Emergency Department (ED) in cardiac arrest. The patient had a history of hypertension, obstructive sleep apnea, obesity (body mass index [BMI] of 39.8 kg/m<sup>2</sup>), and several months of intermittent chest pain. On the day of admission, he was extinguishing a small outdoor fire when he developed substernal chest pain. The paramedics on scene administered aspirin and nitroglycerin. A prehospital 12-lead electrocardiogram demonstrated > 5 mm of ST elevation in the anterolateral leads.

During transport the patient developed VF and received immediate CPR by the paramedics and the patient's son. The patient remained in cardiac arrest during the following 15 min of transport. A King airway was placed, intravenous access was obtained, and the patient received several doses of epinephrine and 300 mg of

amiodarone. He was defibrillated three times with 200 J of biphasic energy but remained in VF.

The patient arrived at the ED receiving CPR by the son and was found to be in VF. Over the next 10 min, the patient received high-quality CPR with minimal interruptions, multiple doses of epinephrine, 1 amp of lidocaine and 1 amp of bicarbonate, and was defibrillated two additional times with 200 J from a biphasic defibrillator with standard anterior and lateral placement (one pad right parasternal and the second at cardiac apex). The patient remained in VF despite a total of 25 min of standard Advanced Cardiac Life Support (ACLS) protocol.

At this point the decision was made to defibrillate with 400 J by using two biphasic defibrillators. This was done by placing a second set of pads adjacent to the initial set, and then charging and defibrillating both machines at the same time (Figure 1). The patient then regained a palpable pulse and blood pressure. He had another brief episode of ventricular tachycardia that responded to a second defibrillation with 400 J. The patient had a wide QRS rhythm that quickly narrowed into normal sinus.

The patient was then taken to the cardiac catheterization laboratory where he was found to have diffuse coronary disease with a 100% lesion of the left anterior descending artery. He received a drug-eluting-stent and intra-aortic balloon pump and then was admitted to the intensive care unit. The patient underwent standard post-arrest hypothermia. The patient made a full recovery with no neurologic impairment. At his 6-month follow-up, he had completed cardiac rehabilitation and had no further ischemic events.

## DISCUSSION

VF is the most common initial dysrhythmia in OHCA. Several studies have shown VF is the predominant rhythm, with a rate of 60–70% for all causes of OHCA and a rate of 80–85% for arrest caused by probable heart disease (5). Current resuscitation guidelines stress early defibrillation with a somewhat limited role for antidysrhythmics (7). Although VF typically responds well to defibrillation, up to 79% of patients with VF secondary to OHCA will experience at least one recurrence of VF (8,9). The majority of these cases will be terminated within the initial three shocks, but there are cases where patients may remain in VF (10).

Success of defibrillation depends on several variables, including the length of time in VF, body type, total energy used, and energy waveform. Several studies have shown higher success rates of biphasic waveforms when compared to a monophasic shock (11–13). Body habitus is an important variable, as obesity and chest size will affect the amount of effective energy that will make it to the heart. Zhang et al. demonstrated in a

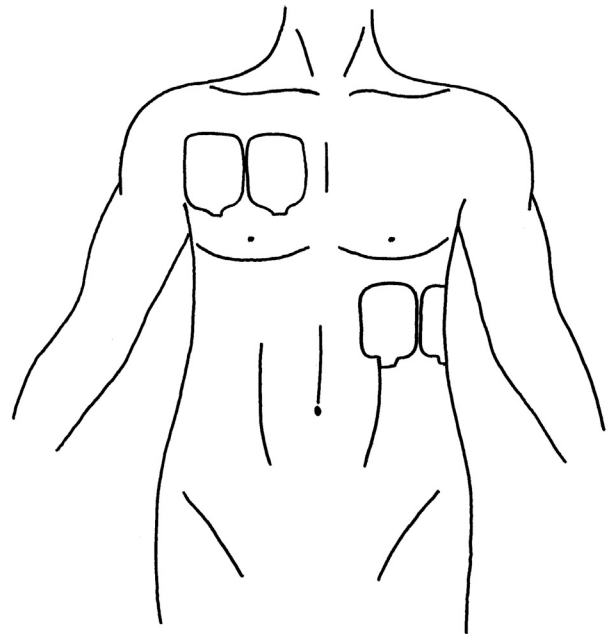


Figure 1. Placement of defibrillator pads.

swine model that body mass had an inverse relationship with the success of defibrillation (14). There have been similar findings in cardioversion of atrial fibrillation (AF) where patients with BMI > 25 had a lower rate of cardioversion at lower energies when compared to patients with a normal BMI (15). This patient had a BMI of 39.8 kg/m<sup>2</sup>, which may explain his intractable VF, despite multiple shocks with 200 J.

The amount of energy used is also an important factor in defibrillation. Human studies of AF have shown that higher levels of energy are associated with a higher rate of cardioversion (15–17). Studies of VF conflict on whether higher energy is more successful for the initial shock, but do show higher energies have improved success for subsequent defibrillation (18–21). Although there are concerns that higher energy may cause chest wall damage or cardiac stunning, several studies have shown safety in humans. Stiell et al. found no deleterious effects of higher-energy biphasic defibrillation up to 360 J (18). Five studies have demonstrated safety in patients receiving 720 J of monophasic energy for cardioversion of atrial fibrillation (17,22–25). The energy was delivered by the use of two standard defibrillators, similar to this report. None of the 125 patients included in these five studies developed hemodynamic instability or stroke.

There is one prior report of the use of double defibrillators for VF: Hoch et al. described a case series of 5 patients with cardiomyopathy or Wolff-Parkinson-White syndrome undergoing routine studies in an electrophysiology laboratory (26). All had VF intentionally induced

with a quadripolar catheter as part of their evaluation. In this series, each patient failed to convert after receiving seven to 20 shocks with monophasic energies ranging from 200 to 360 J. All 5 patients converted after receiving a double shock with a total of 720 J.

To our knowledge, this is the first case report of an OHCA patient with intractable VF to be successfully defibrillated by the simultaneous use of two biphasic defibrillators. There is reasonable evidence for the use of higher energies for patients in VF requiring more than one defibrillation. The 2010 guidelines recommend an initial energy of 150 to 200 J, but state that it is reasonable to increase the energy for subsequent shocks when available (27). Given that commercial biphasic defibrillators have an upper limit of 200 J, it may be reasonable to attempt cardioversion with the simultaneous use of two defibrillators in select patients.

### CONCLUSION

VF is the predominant initial rhythm in OHCA. Although most patients with VF will respond to standard ACLS and prompt defibrillation with standard energies, some patients may not convert with typical measures. We present a case of a patient with refractory VF that converted with 400 J, by the simultaneous use of two biphasic defibrillators. High-energy defibrillation may be a reasonable approach for use in patients with VF not responding to typical therapy.

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