Use of Tandem Perimortem Cesarean Section and Open-Chest Cardiac Massage in the Resuscitation of Peripartum Cardiomyopathy Cardiac Arrest

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Cardiac arrest and resuscitation of the pregnant woman at gestational term is rare. Depending on the circumstances of cardiac arrest and its timing, options are limited for allowing successful resuscitation of both mother and neonate. Herein, we describe the use of tandem perimortem cesarean section and thoracotomy for open-chest cardiac massage in a young woman with newly diagnosed peripartum cardiomyopathy. We used goal-directed resuscitation including diagnostic ultrasonography and capnography to assist in decision making and successfully resuscitated both mother and neonate to hospital discharge without discernable long-term complications. [Ann Emerg Med. 2019;74:772-774.]

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INTRODUCTION

Peripartum cardiomyopathy is defined as the onset of heart failure within the last month of pregnancy or within the first 5 months after delivery.[1] It is a rare emergency requiring simultaneous treatment of mother and neonate. We report successful maternal and subsequent neonatal resuscitation by emergency physicians using cesarean section and tandem open-chest cardiac massage.

CASE REPORT

A 23-year-old, previously healthy, gravida 3, para 2 woman at 38 weeks' gestation and uncertain prenatal care presented to a small emergency department (ED) with progressive dyspnea and lower extremity edema. Bedside echocardiogram demonstrated an ejection fraction of 20%, and the patient's hypoxic respiratory failure rapidly worsened. Physicians intubated her, administered a nitroglycerin infusion, and administered intravenous furosemide. She was then transported to our referral ED by ambulance (emergency medical services [EMS]) and arrived an hour later.

She was delivered immediately to our resuscitation bay. EMS providers were unable to obtain a pulse, and we initiated cardiopulmonary resuscitation (CPR) while stopping the nitroglycerin infusion. The initial rhythm was pulseless electrical activity. An emergency physician performed maternal cardiac ultrasonography that demonstrated standstill. Additional ultrasonographically trained emergency physicians performed fetal ultrasonography that demonstrated severe bradycardia. The lead emergency physician—without any obstetric assistance—performed a cesarean section with a vertical incision from xyphoid to pubis. A male fetus was delivered in less than 60 seconds, but was unresponsive, without pulses, and not spontaneously breathing. Emergency physicians initiated immediate neonatal CPR, clamped and cut the umbilical cord, and transferred care directly to another team of emergency physicians to start neonatal resuscitation.

After delivery, the mother remained in cardiac arrest. End-tidal capnography demonstrated acceptable waveform but poor amplitude, at only 4 mm Hg despite appropriate chest compressions and administration of 2 mg of intravenous epinephrine. Given the low capnographic readings, CPR generated poor perfusion. Combined with the short duration of arrest in addition to favorable patient age and baseline comorbidities, our team thought that the mother might benefit from open-chest cardiac massage. The lead emergency physician—without surgical assistance—performed a left lateral thoracotomy and immediately evacuated more than 1 L of serous fluid. There was no pericardial effusion and we deferred pericardiotomy. We then performed direct cardiac massage, with increase in capnography amplitude to greater than 30 mm Hg within 2 minutes.

After 5 minutes of continued resuscitation, the patient achieved return of spontaneous circulation, with mean arterial pressure of 100 mm Hg. ECG demonstrated sinus

tachycardia without ischemic changes. We again performed bedside ultrasonography and estimated an ejection fraction of approximately 20%. Anticipating hypotension, we initiated a low-dose norepinephrine infusion. We empirically transfused 2 units of packed RBCs and administered calcium chloride to help prevent disseminated intravascular coagulation. Arterial blood gas drawn at this time showed pH 7.27, P_{CO_2} 29 mm Hg, P_{O_2} 137 mm Hg, lactic acid 8.5 mmol/L, and glucose 172 mg/dL.

Obstetrics assisted with delivery of the placenta and packed the uterus at bedside. The patient underwent computed tomography to rule out pulmonary embolism and then was transported to the operating room for closure of the open abdomen and thorax.

A separate team of emergency physicians performed CPR on the newborn, along with intubation. The pulse rate improved from 47 to 150 beats/min, with good oxygen saturation and tone. The patient was referred to the neonatal ICU team.

The mother recovered in the cardiac ICU without postoperative complications. She was extubated on day 9 and was discharged on day 21 with no neurologic deficits and an ejection fraction of 25%. The newborn also recovered without complication and was discharged on day 13. Follow-up maternal echocardiogram 6 months after discharge demonstrated an ejection fraction of 56% and improved biventricular function. At 6-month follow-up, the infant was assessed by pediatric neurology and was found to be making appropriate developmental progress without evidence of neurologic deficits.

DISCUSSION

Cardiac arrest in pregnancy is a medical and surgical emergency. Decision making in this setting is guided in large part by the possible cause and estimated duration of cardiac arrest. Although perimortem ED-based cesarean section for maternal cardiac arrest has been reported, to our knowledge this is the first reported case of rapid tandem use of cesarean section and open-chest cardiac massage to successfully resuscitate a mother and neonate.

Cardiac arrest treatment includes simultaneous CPR and bedside cesarean section because chest compressions alone are unlikely to adequately perfuse the fetus.[2] We immediately performed the cesarean section and continued maternal resuscitation while another team of emergency physicians resuscitated the neonate.

The cause of the mother's initial low capnography measurements was unclear but likely attributable to poor cardiac function from her cardiomyopathy, and possible displacement of the heart from typical substernal location by a gravid uterus. Despite delivery of the fetus and significant reduction of aortocaval pressure, capnography remained low. End-tidal P_{CO_2} as measured by capnography has been shown to correlate with coronary perfusion pressure and cardiac output.[3] It also can be used to predict return of spontaneous circulation, with measurements less than 10 mm Hg correlating with decreased probability of return of spontaneous circulation, whereas levels greater than 20 mm Hg correlate with a significantly greater likelihood of its return.[3,4] Given this clinical scenario, we thought that continuation with traditional advanced cardiac life support would be futile.

Open-chest cardiac massage is not novel, and a case series demonstrated a survival rate of 44.8% in operating room patients.[5] Physiologically, open-chest cardiac massage should enhance the chances of return of circulation by increasing coronary perfusion pressure[6] more than would be observed with closed-chest compressions.[7] Small cohort studies and retrospective reviews suggest improved return of spontaneous circulation and survival with open-chest cardiac massage.[8]

It is challenging to determine which patients would benefit from open-chest cardiac massage because it is difficult to directly measure intra-arrest coronary perfusion pressure. However, as noted earlier, capnography values are inversely correlated with return of spontaneous circulation, and the rapid increase in capnography levels indicated that open-chest cardiac massage significantly improved coronary perfusion pressure compared with closed-chest compressions. Release of the large left pleural effusion during thoracotomy may also have contributed to improved coronary perfusion pressure. Although we performed a left lateral thoracotomy, a subdiaphragmatic approach has also been reported in the setting of an open abdomen.[9]

In this case of peripartum cardiomyopathy–associated cardiac arrest of mother and fetus, our emergency team made physiologically guided decisions using a combination of ultrasonography and capnography to perform bedside cesarean section followed by open-chest cardiac massage, resulting in the successful resuscitation of both mother and baby, without discernable complications. We suggest open-chest cardiac massage is worth considering in patients with potentially reversible causes of cardiac arrest and poor objective predictors of return of spontaneous circulation.

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IMAGES IN EMERGENCY MEDICINE

(continued from p. 740)

DIAGNOSIS:

Whippit explosion and globe rupture. The patient sustained a left globe rupture from the explosion of a nitrous oxide canister. Although their intended use is the production of whipped cream (hence the term "whippit"), they are abused for their euphoric, anxiolytic, and analgesic effects. Nitrous oxide canisters are readily available in many stores and online.

One method of dispensing the nitrous oxide gas involves using a "cracker" (the silver item in Figure 2). A cracker has a spike in the inner lid that, when the lid is closed, punctures the canister and releases the gas. A typical canister contains nitrous oxide under a pressure of 725 lb/inch^2. Because the intoxication from a single canister lasts only 30 to 60 seconds, it is common for a person to use more than 100 canisters in a single day, creating ample opportunity for mishap. However, traumatic injury is exceedingly rare.[1,2] More common are the sequelae of chronic abuse. Nitrous oxide binds to the cobalt moiety on vitamin B12, creating a functional B12 deficiency that presents as ataxia, peripheral neuropathy, and megaloblastic anemia.

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