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ACASE OF NEUROLOGICALLY INTACT SURVIVAL AFTER 2 HOURS AND 50 MINUTES OF EUTHERMIC CARDIAC ARREST TREATED WITH MECHANICAL CPR AND INTRA-ARREST PERCUTANEOUS CORONARY INTERVENTION

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ABSTRACT

We report a case of a 56 year old male in ventricular fibrillation (VF) cardiac arrest for a total of 2 hours and 50 minutes who was diagnosed with ST elevation myocardial infarction (STEMI) during a brief 10 min period of return of spontaneous circulation (ROSC). The patient underwent successful percutaneous coronary intervention (PCI) while receiving mechanical chest compressions for ongoing VF. Our case demonstrates the potential for neurologically intact survival in VF cardiac arrest patients despite prolonged periods of VF who are treated with mechanical CPR and intra-arrest PCI. Key words: cardiac arrest; resuscitation; EMS; prehospital

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CASE

An urban, fire based, advanced life support ambulance was dispatched to a witnessed cardiopulmonary arrest of a 56 year old male. Bystander CPR was initiated and pre-arrival instructions were provided over the phone by an Emergency Medical Dispatcher (EMD). EMS arrived 5 minutes after being dispatched. Standard chest compressions and bag-valve-mask ventilation were performed while a defibrillator was attached. Ventricular fibrillation (VF) was diagnosed and the patient received a total of 3 defibrillations, two 1mg doses of epinephrine, 2mg of naloxone and 450 mg of amiodarone (300 mg +150 mg several minutes later). The patient remained in VF and was placed on LUCAS 2, a mechanical chest compression device (LUCAS 2™ Chest Compression System, Physio Control, Redmund, WA). While the device was delivering compressions, the providers noticed the patient had purposeful respirations and that his eyes were open and he appeared to be looking around the room. The providers began to communicate with the patient; when asked, he would blink twice for yes and once for no. This neurologic activity prompted EMS to transport the patient to the hospital in refractory VF with ongoing chest compressions via mechanical CPR device (M-CPR). Total scene time was 16 minutes.

Upon arrival to the hospital, the patient remained in VF and M-CPR was continued. Additional history obtained at the hospital from the patient’s wife revealed that the patient had 2 prior coronary stents. Physical examination demonstrated equal and reactive pupils, spontaneously blinking eyes, spontaneous breathing and purposeful movement of the extremities. Blood pressure under M-CPR was noted to be 80 by sphygmomanometer over the humerus with non-invasive oxygen saturations in the 80’s and end tidal CO2 varying between 20 and 36. Bedside echocardiography demonstrated no organized cardiac activity. The initial venous pH was 7.16 with a troponin of 0.012. During the resuscitation the patient required drug assisted endotracheal intubation secondary to a clenched jaw; subsequent sodium bicarbonate (150 meq), epinephrine (12mg), and an amiodarone drip were administered during the ED course. Despite 19 defibrillations, the patient remained in refractory VF (RVF) alternating with asystole/pulseless electrical activity (PEA). During pulse checks the patient lost all movement noted on the initial exam which would return several seconds after M-CPR was restarted.

Fifty-five minutes after arrival to the Emergency Department (ED), a second venous pH returned at 6.85. At this time the neurologic exam showed persistent spontaneous blinking and eye movement. Nine minutes later the patient developed return of

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spontaneous circulation (ROSC) with a normal sinus rhythm (NSR). An EKG demonstrated an anterior STEMI (Figure 1). He was given rectal aspirin, an unfractioned heparin bolus and drip as well as a clopidogrel load and was transferred to the cardiac catheterization suite for PCI. Total duration of cardiac arrest in the ED was 75 minutes.

Approximately 10 minutes after leaving the ED, the patient reverted to VF. M-CPR was restarted and coronary angiography was performed with M-CPR delivering chest compressions. An additional 13 defibrillations and 4 mg epinephrine were administered (Table 1). A 100% thrombotic occlusion of the previously placed left anterior descending coronary artery stents was diagnosed. Thrombectomy was performed and 2 drug eluting stents were inserted. A subsequent defibrillation resulted in ROSC. The patient was in RVF in the catheterization suite for a total of 79 minutes. An intra-aortic balloon pump (IABP) was placed and the patient was transferred to the coronary care unit (CCU) where he underwent therapeutic hypothermia.

The patient’s condition in the CCU improved rapidly. A course of therapeutic hypothermia was completed followed by uneventful extubation. The patient’s cardiogenic shock resolved and the IABP was shut off <24 hours after placement. The initial ejection fraction post resuscitation was 20% which has increased over several weeks to 51%. The patient was ambulatory without assistance, fully conversant and with only mild memory impairment. He had recollection of portions of the resuscitation which prompted a psychiatry consult for potential post-traumatic stress disorder. The patient was discharged home 11 days later with a cerebral performance category rating of 1 (CPC-1). After cardiac rehab he was able to return to work, and after 3 years and 4 months he remains active and employed with no signs of neurologic impairment.

**Discussion**

Survival from out of hospital cardiac arrest (OHCA) requires a coordinated response along all
steps of the chain of survival. Early recognition, bystander CPR, and prompt defibrillation have been associated with intact neurologic survival from OHCA (1). However, duration of cardiac arrest remains a common prognostic factor and the rate of neurologically intact survival in eutermic patients who have not achieved ROSC after 15 minutes of resuscitation has been reported at approximately 2% (2). Importantly, these studies were performed while the patients were receiving standard CPR (S-CPR).

Mechanical CPR devices have the benefits of not suffering fatigue, standardizing the rate, depth and compression fraction and allowing for effective CPR to be performed in a moving ambulance (3). With S-CPR, compression quality metrics degrade significantly during the ambulance transport but this degradation can be mitigated through the use of M-CPR (4). However, to date there have been no studies demonstrating improvement in survival to hospital discharge from the use of M-CPR devices (5–7). We believe the benefit of M-CPR, as demonstrated in our case, is allowing EMS providers to transport select patients from the scene to the hospital where interventions such as intra-arrest PCI may be performed with M-CPR on-going.

Patients with RVF have been shown to have a high rate of thrombotic occlusion amenable to PCI as the proximate cause of their cardiac arrest. Yannopoulos et al. reported a high incidence of complex coronary artery disease, including acute and chronic major artery occlusion in the setting of RVF. Of the 55 patients undergoing coronary angiography for RVF, 35 (64%) had acute thrombotic occlusion and 46 (84%) underwent PCI (8). These high rates of coronary artery occlusion suggest that RVF is a STEMI equivalent and, as such, is a good candidate for consideration of intra-arrest PCI under M-CPR.

Coronary angiography and PCI can be successfully performed in patients undergoing active chest compressions with M-CPR. Traditionally, chest compressions were felt to compromise the ability to successfully navigate the intra-arterial system, cannulate a coronary artery and perform a PCI. However, with the use of M-CPR there are reports of successful PCI for patients in cardiac arrest receiving active chest compressions (9). Successful PCI under M-CPR has been reproduced at several centers demonstrating the feasibility of this intervention (10, 11). Cases considered candidates for intra-arrest PCI under M-CPR include those with documented STEMI who suffer a cardiac arrest prior to arrival in the angiography suite. Our case emphasizes that in the setting of preserved neurologic activity the duration of cardiac arrest should not impede the decision to preform angiography and PCI.

There have been previous reports of intact neurologic function after prolonged episodes of eutermic CPR. In one case a 36 year old female suffered 340 minutes of intermittent CPR due to propafenone overdose successfully treated with a combination of standard and mechanical CPR (12). Successful neurologic resuscitation from cardiac arrest from shockable rhythms treated with S-CPR have been reported after 74 and 96 minutes of CPR (13, 14). Cases of cardiac arrest of presumed cardiac etiology have been resuscitated with MCPR after up to 115 minutes with good neurologic outcome (15). MCPR has also been used successfully in a case of in-hospital cardiac arrest from anaphylaxis with 50 minutes of cardiac arrest prior to a neurologically intact recovery (16). Our case is unique in that M-CPR was used for a total of 2 hours and 50 minutes to treat a case of cardiac arrest secondary to a STEMI that originated in an out of hospital setting, required transport via EMS and in-hospital PCI.

This case report highlights the limitations of extrapolating prognostic factors initially devised in the era of S-CPR to the era of M-CPR with intra-arrest coronary angiography and PCI. Despite an extensively prolonged resuscitation and a decline in pH from 7.16 to 6.85 during the course of the resuscitation, our patient had a successful neurologic outcome. We hypothesize that purposeful neurologic activity intra-arrest suggests preserved cerebral perfusion and should advocate for continued aggressive resuscitation. Physicians must ensure the fundamental components of the chain of survival are intact in their communities and they should consider implementing protocols instructing prehospital providers to transport RVF cases to the hospital under M-CPR for consideration of intra-arrest PCI. In our case, despite aggressive traditional resuscitative techniques including epinephrine, amiodarone and 34 defibrillations, it was not until post-thrombectomy, when coronary blood flow was restored, that sustained ROSC occurred. The patient was discharged from the hospital with a cerebral performance category score of 1 (CPC-1), which suggests a favorable long term prognosis (17).

**Conclusion**

We report a case of refractory ventricular fibrillation, secondary to a STEMI, with a total of 2 hours and 50 minutes of mechanical CPR and 35 defibrillations for a patient who underwent a successful intra-arrest PCI and was discharged neurologically intact. Prognostic factors, including duration of
cardiac arrest, developed in the era of standard CPR may not translate to patients undergoing mechanical CPR. The presence of purposeful neurologic activity during cardiac arrest should encourage clinicians to continue resuscitation with transfer from the field to the hospital if M-CPR is available. If STEMI is diagnosed and the patient re-arrests, PCI under mechanical CPR may be considered.

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