Partial Hepatectomy of a VA-ECMO Patient After Mechanical CPR by LUCAS Device Due to a Catastrophic Liver Laceration: A Case Report

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Patient: Male, 56-year-old
Final Diagnosis: Liver laceration
Symptoms: Abdominal hypertension • acute renal failure • hemodynamic instability
Clinical Procedure: Hepatectomy
Specialty: Critical Care Medicine

Objective: Rare coexistence of disease or pathology

Background: Many patients experiencing acute coronary syndrome (ACS) present in cardiac arrest. Mechanical chest compressions are a common tool in cardiopulmonary resuscitation (CPR) and have their benefits as well as disadvantages and reported complications. In recent years, veno-arterial extracorporeal oxygenation membrane (VA-ECMO) has proven to be a promising tool in these circumstances and is now considered part of the treatment algorithm in emergent and refractory cases. The combination of mechanical compressions and the ECMO lead to “new” complicated situations in the patients. We discuss such a patient, who required emergent surgery due to complications from his resuscitation, while under ECMO.

Case Report: A 56-year-old man, with medical history of cardiovascular risk factors, presented to our facility due to ST segment elevation myocardial infarction. During his catheterization, he went into cardiac arrest and needed cardiopulmonary resuscitation (CPR) using a LUCAS3™ device. Because no rhythm was restored, he was promptly placed on VA-ECMO support with immediate, albeit transient, stabilization. After transportation to our Intensive Care Unit (ICU), he quickly deteriorated again hemodynamically and after imaging workup it was discovered he had a major laceration to his liver and was rushed emergently to the operating room where he underwent partial hepatectomy, while on full anticoagulation due to the ECMO support.

Conclusions: Complications from mechanical CPR are common, including liver laceration. Patients who are placed on ECMO following such measures should be carefully evaluated for such complications as they might affect the treatment and prognosis.

Keywords: Cardiopulmonary Resuscitation • Extracorporeal Membrane Oxygenation • Hepatectomy

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Background

Acute coronary syndrome (ACS) is a common presenting medical emergency that, in some cases, requires urgent coronary artery intervention [1]. Sudden cardiac arrest (SCA) and arrhythmias in such patients can be both the presentation or a complication during the interventions. Effective cardiopulmonary resuscitation (CPR) is essential in these instances and the use of external mechanical compression devices, such as LUCAS3™, can improve the effectiveness of CPR, though they are not without risks [2,3]. The benefits of extracorporeal membrane oxygenation-CPR (e-CPR) for enhancing the outcomes of patients undergoing CPR related to life-threatening arrhythmias during ACS have come to light in recent years and its use is on the rise [4,5]. As a result, the literature is also experiencing a rise in reports of complications in such cases, and care is needed in diagnosing and treating these critical patients as early as possible.

We present a case of a patient who was placed on VA-ECMO while undergoing mechanical CPR, during which he suffered a hepatic laceration, necessitating immediate surgery.

Case Report

A 56-year-old man with past medical history positive for prediabetes and hyperlipidemia, presented with ST-elevation myocardial infarction and was immediately transported to the catheterization lab for primary percutaneous intervention (PCI). His left anterior descending (LAD) artery was found to be occluded, and a stent was implemented after aspiration of a thrombus. Shortly after stent deployment, due to the no-reflow phenomenon, the patient became hemodynamically unstable, with ventricular fibrillation (VF) and later pulseless electrical activity (PEA) appearing. CPR was commenced immediately with the assistance of the LUCAS3™ device, which is usually applied due to its ability to provide chest compressions during the intervention. A decision to use ECMO was taken following 2 rounds of CPR without a return-of-spontaneous-circulation (ROSC). Within 10 minutes of the call, cannulation (23F in the right femoral vein and 17F in the femoral artery) was completed thanks to the combined efforts of the ICU and catheterization lab-trained teams. CPR was discontinued after an apparent hemodynamic improvement with an overall time of roughly 15 minutes from CPR start to end of cannulation. The PCI was finished with LAD flow restored, although three- vessel disease was evident. The patient was taken to the general ICU while on ECMO, as is common in our hospital.

After transport to the ICU and waking up, the patient was rapidly weaned off mechanical ventilation while demonstrating no significant neurological consequences. A few hours later, the patient began to deteriorate despite VA-ECMO support as lactate levels reached 15.3 mmol/l and high doses of both vasopressors and inotropes (maximal doses of 0.36, 0.67, and 0.21 mcg/kg/min of Norepinephrine, Terlipressin, and Adrenaline, respectively) were administered. The cannula positions were checked (using both X-ray and US), and the ECMO machine was operating appropriately. The patient’s hemoglobin (Hgb) suddenly fell from 14.5 g/dl on admission to the intensive care unit, to 8.3 g/dl at its lowest in a few hours. A probable focus of the patient’s bleeding was thought to be in his right proximal leg or pelvis (cannula insertion site), particularly after repeated attempts to achieve distal perfusion and a local hematoma present on inspection. Following a massive

Figure 1. Abdominal CT scan. On the left, coronal view of abdominal CT showing hemoperitoneum surrounding the hepatic capsule (yellow arrow) as well as hepatic laceration (blue arrow). On the right, cross section of abdomen showing measurement of intrahepatic hematoma as well as surrounding subcapsular hematoma (red arrow).
blood transfusion protocol involving blood products – up to 15 packed red blood cells (PRBC), 3 fresh frozen plasma, 10 units of cryoprecipitate, and 20 units of platelets, in 24 hours – there was a slight improvement, with lactate dropping to 6 mmol/l and Hgb raising to 11.2 g/dl; but this was only a short-term improvement, as the patient quickly worsened, this time presenting signs of abdominal compartment syndrome with an inflated abdomen, evidence of intraabdominal hypertension of 16 cmH₂O, declining urine output, and an increase in creatinine to 2.6 mg/dl. He required larger doses of vasopressors, and blood tests also showed a persistent tendency of raised lactate up to 14 mmol/l and Hgb that did not improve more than 11 g/dl despite ongoing transfusions (2 more rapid infusions of PRBC). Despite the patient’s critical condition and the logistical challenges of transferring a patient on VA-ECMO, we concluded it was unavoidable, and the patient was transported and underwent abdominal computed tomography (CT), which revealed significant hemoperitoneum with grade IV liver lacerations, which was most probably caused by the mechanical CPR the prior day (Figure 1). Following consultation with the

Figure 2. Hepatectomy. Specimen of lacerated liver lobe in operating room.

Figure 3. Echocardiography Day 3. Echocardiograph of the patient on day 3 of hospitalization showing velocity time interval (VTI) has increased to 11.8 cm which was correlated to approximately 30-35% EF.

Figure 4. Echocardiography Day 5. On the left, pulse wave (PW) images showing a reduction in VTI to 4.2cm correlating approximately to 10-15% EF. On the right, cross section echocardiographic images using the “Simpson” estimation of 16% EF.
general surgeons, the patient was transported to the operating room to undergo a left lobectomy of the liver after being provided general anesthesia (Figure 2).

After the procedure, he was extubated and returned to the ICU, where his condition quickly improved. Vasopressors were reduced to a minimum, lactate levels returned rapidly to normal, and only 3 additional PRBC transfusions were given the same day, maintaining the Hgb level at 10-11 g/dl, the baseline we target for ECMO patients. On a second echocardiogram taken a few days later, the patient’s condition improved, his ejection fraction (EF) improved to 30-35%, and it was thought he was close to being weaned off ECMO (Figure 3).

However, on day 4 he began having arrhythmias, initially with non-sustained VT and then ventricular fibrillation, which required defibrillations. A repeat echocardiography on the following day showed that the EF was again reduced to approximately 16% even though the arrhythmias stabilized (Figure 4). After a second evaluation of the patient’s status and echocardiographic imaging, it was decided to transfer him to another hospital for LVAD implantation, and after a total of 7 days of hospitalization he was transferred. On that day, the patient was supported by ECMO, breathing spontaneously using nasal prongs, hemodynamically stable without vasopressors, awake and alert, and with no gross apparent neurological sequelae. Unfortunately, several days after the transfer, he had catastrophic multiorgan failure due to sepsis and died soon thereafter.

Discussion

According to the American Heart Association (AHA), registries in 2016-2018 in the United States still cite cardiovascular disease as the leading cause of death [1]. Furthermore, the Cardiac Arrest Registry to Enhance Survival (CARES) reports an estimate of 74 per 100,000 cases of emergency medical service (EMS) treated out-of-hospital cardiac arrest (OHCA), with an increased prevalence in regions such as Michigan, Pennsylvania, North Carolina, and Washington; and an overall survival rate to hospital discharge of 7.8-15.3%. The feasibility and availability e-CPR have improved since the first reported cases [4]. The ELSO estimates that over 11,000 patients globally will require e-CPR in 2022 and that 30% of those patients will survive until discharge or transfer [6].

Natural consequences of rising usage include an increase in reports of adverse events, some of which are related to ECMO and its associated therapies; others, however, are related to the trigger event and preceding treatments, and have profound effects on its procedures and patient management. Along with its many advantages, conventional mechanical CPR has drawbacks, including case studies that use the LUCAS3™ device as an example [2]. In a prospective study performed on 222 CPR patients, the mechanical compression group had more patients who had fractured ribs than the manual compression group (78.8% vs 64.6%). In addition, the liver damage was more severe when compared to the control group (4.3% vs 2.4% injury to the capsule and 3.6% vs 1.2% injury to the liver parenchyma, respectively) [3].

As we were reviewing the literature, we came across another similar case of a female patient who had been placed on VA-ECMO due to a severe pulmonary embolism and who had sustained a liver laceration as a result of LUCAS3™ mechanical CPR [7].

The management of ECMO patients present its own unique set of challenges; however, the rising popularity of the technology due to its accessibility and the promising results it has produced, resulted in even more difficult choices and issues, one of which is management of an unstable patient supported by ECMO, both in terms of transport to imaging or the operating room, and the necessary use of systemic anticoagulation in a surgical patient, or even an already bleeding one such as our patient.

According to recent research, patients on ECMO should always undergo CT scans when problems are suspected [8,9]. Patient transport is a topic that is briefly discussed in the ELSO guidelines as well, usually with a warning to avoid using it unless necessary if it could affect the course of therapy [10].

At our hospital, the ICU is nearby, but on a different ward from the catheterization lab; this means that regardless, the patients are being transported while supported by the ECMO. This raises the question of whether all patients should get a complete body CT in search of complications. Although it presents a logistical challenge, the transport team is already in place, and such imaging might help in identifying issues that will arise in the upcoming hours to days, ranging from abdominal hemorrhage like in our patient to intracerebral bleeding and severe brain edema from the CPR that might lead to a decision for withdrawal of support.

We assert that if precautions and standards are taken, transferring these individuals via a total body CT should pose low risk to the patient, assist in treatment, and be safer than waiting until complications develop. To find the answer, more study on the topic is required.

Conclusions

The above case presents a patient that suffered complications from mechanical CPR which were discovered later while he was...
already on ECMO. If performance of an imaging study is not putting the patient in extreme danger, it might be prudent to perform such a study in order to find complications early that may influence the treatment of these patients.

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