Stenting a Moving Target

Neurological and Hemodynamic Recovery after 80 Minutes of CPR Using an Automated Chest Compression Device to Facilitate Percutaneous Coronary Intervention

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Despite significant advances in the science of resuscitation, survival to discharge after an in-hospital cardiac arrest in the catheterization laboratory remains poor. Clinicians face the challenges of performing CPR during procedures to address the cause of the arrest and the limitations of prolonged manual CPR. In this article we describe the first case of a patient presenting in cardiogenic shock caused by acute coronary syndrome secondary to bypass graft failure who developed cardiac arrest and survived 80 minutes of resuscitation in the catheterization lab, allowing for revascularization of a vein graft. The patient experienced complete neurological and hemodynamic recovery. This case demonstrates the importance of prompt high-quality, uninterrupted CPR using an automated chest compression device to facilitate early emergent revascularization of a vein graft.

Patient outcomes as measured by survival to discharge after a cardiac arrest in the catheterization laboratory are often poor. Although most patients need only cardiopulmonary resuscitation (CPR) and defibrillation to restore spontaneous circulation, cases have been described in which prolonged resuscitation efforts in the catheterization laboratory are necessary. Determining how long to continue high-quality CPR if no return of spontaneous circulation occurs is very challenging for clinicians. Their decisions about when to terminate resuscitation are often driven by the knowledge that rate of survival to discharge is poor and that prolonged manual CPR can be impractical during a procedure, as staff may become fatigued and be exposed to radiation, and it may obscure the field of view. Automated CPR, in contrast, can provide the high-quality, uninterrupted compressions needed to facilitate primary percutaneous intervention.

We describe the case of a patient who presented with acute coronary syndrome and cardiogenic shock and developed cardiac arrest in the catheterization laboratory. The patient required 80 minutes of manual and automated CPR during percutaneous intervention of a vein graft and had complete neurological and hemodynamic recovery.

Case

A 62-year-old man who had received a liver transplant for hepatitis C and had recently undergone four-vessel coronary artery bypass grafting (CABG) presented to an outside hospital with severe substernal chest pain that had continued for several hours. He was transferred to our cardiac catheterization laboratory for acute coronary syndrome with cardiogenic shock within 30 minutes of presentation to the emergency room.

Upon arrival in the catheterization lab, he was tachycardic (110 bpm) and hypertensive (76/40 mmHg). His electrocardiogram demonstrated sinus tachycardia with
Automated compression resulted in systolic augmentation of 100mmHg. An intra-aortic balloon pump was placed with synchronization to the LUCAS compressions for diastolic augmentation, and the patient was given dopamine infusion while preparing for intervention. Right anterior oblique cranial projection after complex bifurcation left main, left anterior descending, and circumflex intervention using peripheral bypass.

2 mm ST segment elevation in lead AvR with ST segment depressions in precordial leads and initial troponin of 7.6 ug/L.

Emergent diagnostic coronary angiography was performed. It showed an atretic left internal mammary artery graft to a small third diagonal artery with a 99% lesion at the touchdown site, complete occlusion of the vein grafts to the first marginal and first diagonal, and 95% long diffuse lesion in the proximal and mid segment of the vein graft to the right coronary artery (this was believed to be the culprit lesion). A highly calcified, critical left main, ostial left anterior descending and LCx lesions were also noted (Figure).

The patient became increasingly hypertensive and bradycardic despite initiation of dopamine infusion. He then became unresponsive. He was intubated, and manual CPR was initiated. Cardiac surgery was consulted about re-doing the CABG. Given the ongoing CPR and the fact that the patient had had CABG within three months of presentation, it was determined he was very high risk for emergent cardiac surgery. During rhythm checks, he remained in persistent ventricular tachycardia that was not responsive to defibrillation or antiarrhythmic therapy with amiodarone. The decision was made to revascularize the culprit vein graft to the right coronary artery lesion.

Manual CPR became impractical during intervention because of poor visualization and significant radiation exposure to the personnel performing the compressions. Manual chest compressions were stopped for less than one minute to set up the LUCAS automated chest compression device (Physio Control, Redmond, Washington).

FIGURE

Coronary angiography
A) Pre-CABG angiogram in left anterior oblique caudal projection demonstrating dominant right coronary artery with 90% proximal stenosis. B) Bypass angiography of the saphenous vein graft to right coronary artery in left anterior oblique cranial projection at the time of acute coronary syndrome demonstrating a long diffuse 95% lesion in the proximal and mid body of the graft with TIMI II flow distally. C) Right anterior oblique cranial projection of percutaneous coronary intervention of the saphenous vein graft to right coronary artery with restoration of TIMI III flow during cardiac arrest and ongoing mechanical CPR (arrow denotes LUCAS CPR device). D) Left anterior oblique cranial projection of left internal mammary artery, demonstrating atretic left internal mammary artery with 99% lesion at D3 touchdown. E) Left anterior oblique caudal projection of the native left circulation demonstrating critical calcified left main, ostial LAD and ostial circumflex lesions. F) Left anterior oblique caudal projection of the native left circulation demonstrating critical calcified left main, ostial LAD and ostial circumflex lesions.
ration of TIMI III flow. (See video at www.minnesotamedicine.com/CPR.)

The patient underwent a total of 80 minutes of CPR (10 minutes manual and 70 minutes automated) from the initial arrest through completion of the revascularization. After successful revascularization of the vein graft to the right coronary artery, he remained in ventricular tachycardia until he was successfully defibrillated with 200J with return of spontaneous circulation and normal sinus rhythm. A cooling catheter was placed with the intent of initiating therapeutic hypothermia; however, the patient was responsive and able to follow commands immediately post-arrest. A decision was made to forgo cooling.

The patient was supported in the ICU with hemodynamic support including intra-aortic balloon pump and inotropes for 10 days. He was then brought back to the cardiac catheterization laboratory for high-risk complex bifurcation left main, left anterior descending and circumflex stenting using peripheral bypass (Figure). The patient subsequently recovered with improvement in left ventricular function from 15% to 35% by echo on discharge. Three months later, he had complete normalization of left ventricular function and no residual neurological deficits.

**Discussion**

This case demonstrates the importance of early emergency services response and prompt high-quality, uninterrupted CPR using an automated chest compression device in the catheterization laboratory to facilitate emergent revascularization in a patient with acute coronary syndrome and cardiac arrest in the absence of an underlying survivable rhythm.

The major advantages of using the LUCAS device are that it can provide high-quality uninterrupted CPR and it allows for adequate cineangiographic imaging to facilitate life-saving percutaneous intervention. As demonstrated in the figure, either left anterior oblique or right anterior oblique projections with caudal or cranial angulation allow for adequate coronary imaging without significant obstruction from the largely radiolucent LUCAS device.

Automated compression devices have been studied primarily in cases of out-of-hospital cardiac arrest. The AutoPulse Aspire trial compared outcomes of 554 patients who received automated CPR with those of 517 patients who received manual CPR. There was no significant difference between the groups in terms of four-hour survival (~25%) or neurological recovery. The recent multicenter LUCAS in cardiac arrest trial (LINC) evaluated a large cohort of patients in Europe who had out-of-hospital arrest. The investigators found no significant difference in survival between those who received automated or manual CPR. There was, however, a trend toward improved neurological outcomes in the group that received automated CPR. Smaller studies have focused on the use of automated CPR devices in the catheterization laboratory and have demonstrated relatively poor survival outcomes. Larsen et al. described 13 patients with cardiac arrest before arrival to the catheterization laboratory who received an average of 105 ± 60 minutes of automated compression device resuscitation in the lab during percutaneous coronary intervention. Of those patients, three survived the intervention; none of them survived to discharge. In a retrospective study of 43 patients primarily with acute coronary syndrome who received automated CPR initiated in the catheterization laboratory, Wagner et al. found 26% (11/43) survived to hospital discharge with good neurological outcome. Of the patients who did survive, the average CPR time was only 16.5 minutes versus 28.2 minutes for the entire cohort.

**Conclusion**

In this case, the use of automated high-quality uninterrupted CPR initiated in the catheterization laboratory was critical to allowing for percutaneous coronary intervention and survival with hemodynamic and neurological recovery. Working in this patient’s favor was the fact that cardiac arrest took place in the catheterization laboratory after the initial diagnostic angiogram, allowing for no delay in both high-quality manual and automated compressions and percutaneous coronary intervention. Additionally, the catheterization laboratory personnel’s comfort in using the automated compression device was important.

There may be a role for automated CPR in a select group of patients who arrest in a catheterization laboratory. However, further evaluation of outcomes in patients with ischemic cardiac arrest who undergo prolonged CPR in the laboratory is needed.

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**References**