The VAD Journal: *The journal of mechanical assisted circulation and heart failure*

Peer-Reviewed Case Report

Right ventricle chest compressions: do we need a new paradigm for LVAD patients needing resuscitation? A case report

Citation: Bhimaraj A.et al. (2017) "Right ventricle chest compressions: do we need a new paradigm for LVAD patients needing resuscitation? A case report**".**

The VAD Journal, 3. doi: https://doi.org/10.13023/VAD.2017.09

Editor-in-Chief: Maya Guglin, University of Kentucky

Received: July 5, 2017

Accepted August 6, 2017

Published: August 6, 2017

Funding: Not applicable

Competing interests: Arvind Bhimaraj and Jerry D. Estep receive consulting fees from St. Jude's Medical.

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Abstract

The use of chest compressions in patients with left ventricular assist devices (LVAD) have been viewed to cause a potential damage to the outflow graft and hence have been a topic of controversy. We report a case of a LVAD patient who needed chest compressions during resuscitation for severe right ventricular failure. With the presence of trans-esophageal echocardiogram we noticed that the chest compressions did not need to be full ACLS compressions but modified to gentle right ventricular (RV) compressions in order to move blood into a normally functioning LVAD. We report this as a call for the LVAD medical providers to rethink concepts of standard resuscitation.

Keywords: left ventricular assist device, cardiopulmonary resuscitation, chest compressions

Introduction

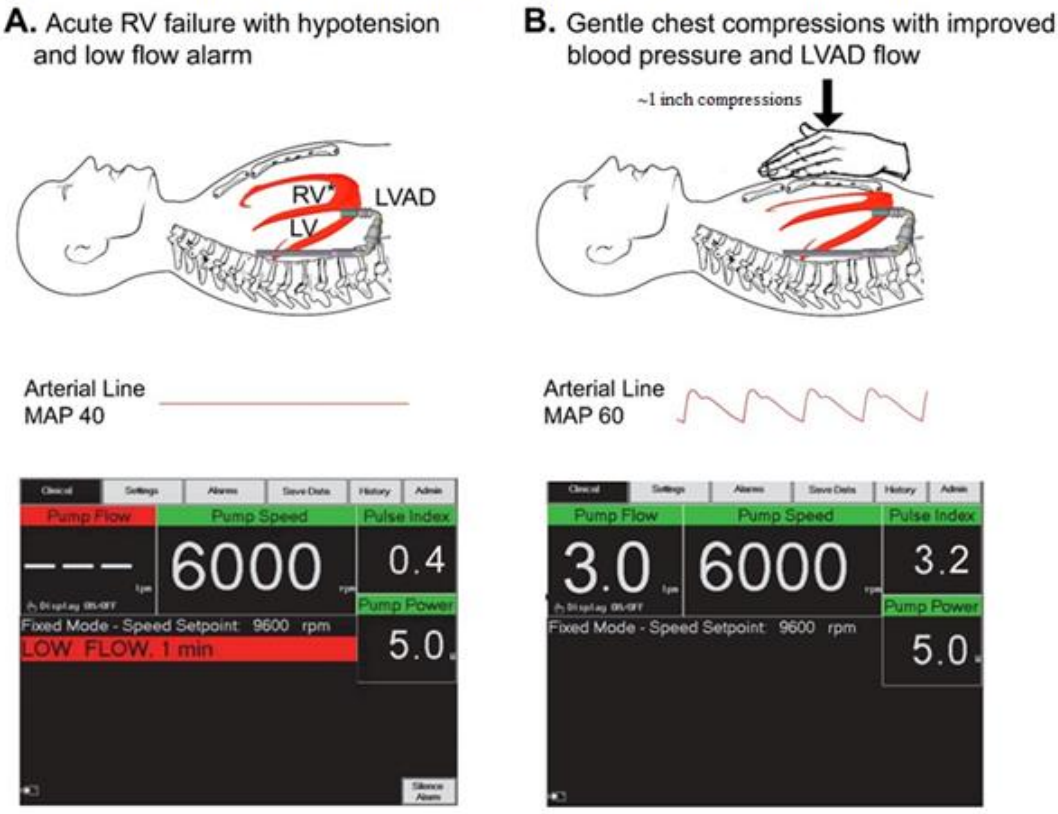
Practice guidelines for cardiopulmonary resuscitation in patients with mechanical circulatory support have been published for the first time, but acknowledge the knowledge gaps in relation to the risk/benefit of chest compressions (1). Though the consensus of the group was to implement chest compressions in a patient with a VAD in true circulatory failure, the manufacturers of these mechanical devices have historically warned against chest compressions due to risk of cannula dislodgement.(2, 3) While small case series have reported safety (4) many continue to argue against chest compressions and reserve the crucial part of resuscitation as a last resort. Some surgeons have even suggested opening the chest for direct cardiac compressions, especially early after an implant. One of the causes of vascular collapse in patients with LVADs is a lack of blood flow into a normally functioning LVAD, due to conditions like severe RV failure, cardiac tamponade and pneumothorax in which the LVAD mechanics are functioning well. We present a case where we serendipitously discovered that gentle chest compressions might be enough to move blood from a failing right ventricle into a functioning LVAD. This is in stark contrast to the classic ACLS protocol which recommends a 2 inch chest compressions in order to effectively compress the entire heart.

Case Report

A 50 y/o normal build male with a HeartMate II (Thoratec Corp., Pleasanton, CA) implant 4 weeks prior was undergoing a dialysis vascular graft placement. Upon anesthesia induction, he became hypotensive and had significant low flow alarms on the LVAD console with mean pressure on the arterial line reading 40 mm Hg. A transesophageal echocardiogram (TEE) revealed an obliterated left ventricular and atrial cavities with a severely dilated and immobile right ventricle suggestive of acute right heart failure with an underfilled left side (the patient had known RV dysfunction needing nitric oxide during and after his LVAD implant). Volume resuscitation and gradual reduction in LVAD speed from his baseline of 8600 to as low as 6000 rpms showed minimal increase in the LV cavity size. Due to a lack of sustained clinical improvement in systemic blood pressure despite such efforts, boluses of Epinephrine and initiation of Dobutamine, a decision was made to implant an emergent RV assist device. As resources were being mobilized for this emergent procedure, the blood pressure continued to deteriorate with onset of ventricular fibrillation. While the defibrillator was being mobilized (patient did not have an ICD), a pericardial thump was delivered to the chest with a transient improvement of the systemic pressure. It was noted on the TEE that the thump actually contracted the RV to an extent. After cardioversion the patient remained significantly hypotensive with ongoing low flow alarms on the LVAD. Gentle chest compressions were started utilizing one hand to generate an approximately 1 inch chest movement (of note, the patient's chest and body habitus was of an average male) while observing the RV compressions on the TEE. The LVAD low flow alarms resolved and the blood pressure improved with a return of pulsatility in synchrony to the chest compressions (Figure 1). It was observed that any brief interruptions to the chest compressions lead to recurrence of low flow alarms with systemic hypotension and loss of pulsatility. Such compressions were maintained

until surgical sternotomy was performed with direct RV compressions followed by placement of a RVAD. The patient recovered well and was gradually weaned off the RVAD and was discharged home after appropriate recovery. Based on this initial experience we have successfully utilized such gentle RV chest compressions in another instance of hemodynamic collapse due to pericardial tamponade.

Figure 1: A schematic representation of Right Ventricle chest compressions



Discussion

Current adult cardiopulmonary resuscitation guidelines recommend that a rescuer push down at least 2 inches, but no more than 2.4 inches at a rate of 120 times per minute during chest compressions.(5) The purpose of assuring the minimum depth of compressions is tailored towards the concept that blood needs to be compressed out of the posteriorly located, muscular left ventricle. On the contrary, in the presence of a functioning LVAD, as long as the blood is compressed out of the RV and moved into the left side of the heart, the systemic perfusion can be maintained. Hence, the concept of right ventricular CPR. We have shown in a couple instances that this is feasible and might be a safer option in appropriately selected patients in order to avoid damage to the LVAD outflow graft. The recent consensus guidelines recommend a central focused assessment of adequate pump function during cardiopulmonary resuscitation of LVAD patients.(1) We believe that once it is established that the LVAD is functioning appropriately, it

might be adequate to start with right ventricular CPR and assess restoration of perfusion (by arterial line or by partial pressure of end-tidal carbon dioxide). The most relevant patient population to benefit from RV-CPR would be LVAD patients in circulatory collapse due to overt RV failure but, as mentioned above, we have been able to successfully resuscitate using RV-CPR in a situation of pericardial tamponade contributing to vascular collapse with a background of severe right ventricular dysfunction. Further validation of such a technique as a modified CPR for the right ventricle is needed.

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