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Subacute Aortic Rupture Due to Mechanical Chest Compression with Indwelling Impella

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Abstract

Mechanical cardiopulmonary resuscitation (CPR) devices like Lund University Cardiopulmonary Assist System (LUCAS) cause more skeletal and visceral injuries than standard CPR. A 62-year-old woman with ST-elevation myocardial infarction was resuscitated with LUCAS and Impella CP for refractory cardiogenic shock during percutaneous coronary intervention. She suffered delayed ascending aortic rupture necessitating supracommissural ascending aortic replacement plus triple bypass grafting. Prolonged mechanical CPR with concomitant Impella may lead to aortic rupture. The combined use of LUCAS and Impella may have disastrous consequences.

Keywords

- cardiac catheterization/ intervention
- circulatory assist devices
- shock (systemic, cardiac or circulatory)

Introduction

Automated chest compression devices (ACCDs) are effective for prolonged cardiopulmonary resuscitation (CPR) but have been linked to higher incidences of skeletal, thoracic, or abdominal visceral injuries compared to standard CPR with manual chest compressions.[1] Sternal, rib fractures, liver and splenic lacerations have been described with the use of the LUCAS (Lund University Cardiopulmonary Assist System) device. Milling et al described a 10% incidence of LUCAS-related life-threatening injuries in 50 autopsies.[2]

Biventricular rupture plus complete tear of the inferior vena cava with an active compression-decompression CPR was described by Kolopp et al.[3] Many injuries go undetected until autopsy as reflected by the body of literature in forensic journals.

The combined use of an ACCD in conjunction with an internal circulatory assist device like the Impella has a significant potential for iatrogenic injuries to vital structures. We describe a case with traumatic ascending aortic rupture and provide insight into the probable mechanism.

Case Report

A 62-year-old woman was admitted to the cathlab with ST-elevation myocardial infarction due to subtotal occlusion of the left main stem (culprit lesion) and triple vessel disease. During the catheterization procedure, she developed ventricular fibrillation (VF) unresponsive to defibrillation, leading to mechanical CPR with LUCAS. Additionally, an Impella CP was inserted due to persistent VF.

During 1 hour of mechanical CPR, five drug eluting stents (percutaneous coronary intervention [PCI]) were implanted into the left main plus all three major vessels. After stent implantation into the right coronary artery return of spontaneous circulation was achieved and mechanical CPR stopped.

The patient recovered after 24 hours neuroprotective cooling. The Impella was weaned after 5 and the patient extubated after 9 days. She had a left-sided hemiparesis due to cerebral ischemia. After 28 days, she sparked a fever unresponsive to vancomycin after removal of all lines. A transesophageal echocardiogram demonstrated an enlarged ascending aorta (►**Fig. 1**) possibly caused by a paraaortic abscess or a traumatic aortic injury. Computed tomography

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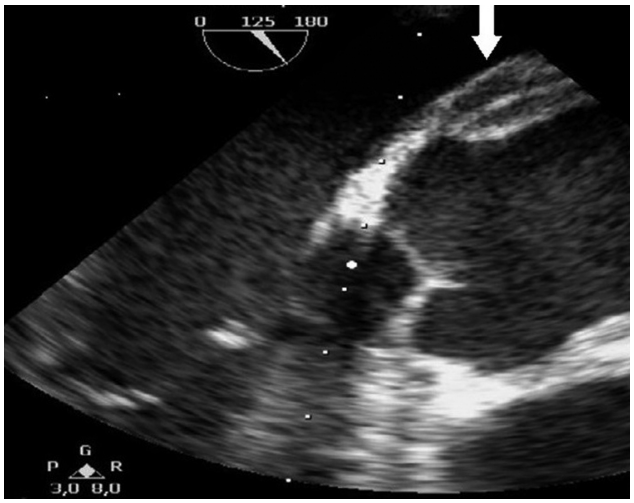

Fig. 1 Preoperative transesophageal echocardiography demonstrating a paraaortic effusion (arrow) believed to be a paraaortic abscess formation.

showed a traumatic rupture of the ascending aorta 5 cm above the aortic valve (►**Fig. 2**).

Urgent surgery was scheduled. Intraoperatively, the aorta showed a livid color as seen with aortic dissections. After cardioplegic arrest and incision of the aorta, several perforations along the outer curvature were noted (►**Fig. 3**). The patient underwent supracommissural replacement of the ascending aorta with a 28 mm vascular graft plus triple bypass grafting to the three major coronary arteries. The distal anastomosis was done in an open fashion during a brief period of deep hypothermic circulatory arrest at 25.5°C. The postoperative course was uneventful. She was discharged home on postoperative day 10 and has been followed by our aortic disease outpatient clinic for 4 years now.

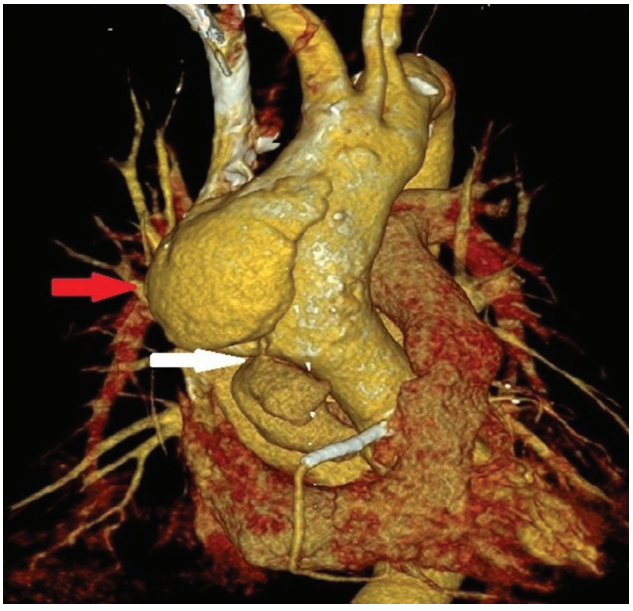

Fig. 2 Computed tomographic reconstruction of contained rupture of the ascending aorta approximately 5 cm above the aortic annulus (white arrow) and aneurysmatic ascending aorta distally (red arrow).

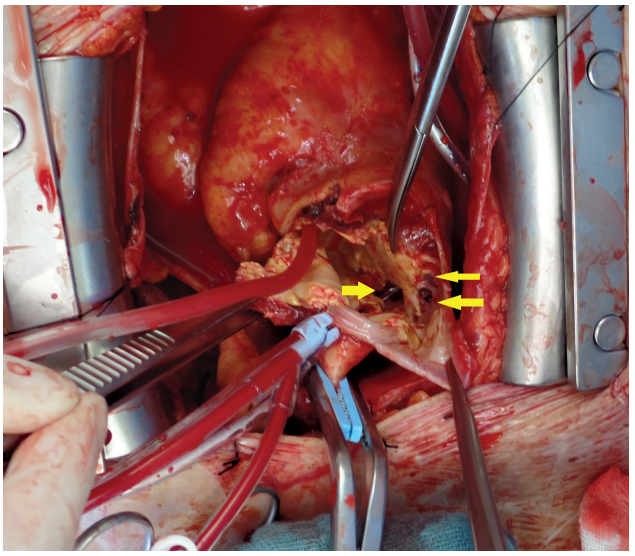

Fig. 3 Multiple perforations of the aortic wall caused by the Impella pump (arrows). The patient's head is at 6 o'clock.

Review of the PCI procedure revealed excessive deflections of Impella pump head by every single LUCAS compression pushing the Impella against the outer curvature of the aorta (►**Video 1**) that probably caused this peculiar injury pattern.

Video 1

Excessive deflection of Impella catheter by LUCAS ® ACCD. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0042-1757873.

Comment

Prolonged mechanical CPR is recommended in special circumstances as defined by the European resuscitation guidelines.[4] Numerous reports have described more injuries with ACCDs than with standard manual CPR.[1,2,5] Ondruschka et al[1] demonstrated more frequent hemothorax (8.9 vs. 1.2%), pneumothorax (6.2 vs. 0.6%), and lung lesions (18.6 vs. 4%) with ACCD versus manual CPR. Great vessel injury was rare (2.7 vs. 1.2%), but no major injury could be identified as the cause of death.

The injury pattern differed depending on the duration of CPR with ACCDs and mechanical CPR. Any type of injury was more common with longer CPR duration for both groups.[1] The patient described required 62 minutes of ACCD support and fits into the longer CPR group as defined by Ondruschka et al.[1] The data on fatal injuries due to mechanical CPR is inconclusive. While Milling et al reported a 10% incidence of fatal injuries after mechanical CPR with the LUCAS device,[2] Smekal et al did not detect a single fatal injury in 139 patients resuscitated with the LUCAS device.[5]

The simple implantation technique and rapid availability have facilitated rapid spread of the Impella device for

temporary mechanical circulatory support of the left ventricle among interventional cardiologists.[6] The combined use of an ACCD and the Impella CP device was described by Asrress et al[7] and represents a combination of two different extended CPR measures. Preclinical data in a swine model showed better 24 hours survival when a LUCAS II was used in conjunction with an Impella 2.5l in comparison with manual chest compressions, LUCAS, or Impella alone.[8]

In the patient described, biventricular failure led to persistent VF. Otherwise, Impella alone should have helped if the reason for persistent VF had been an isolated left ventricular problem due to left coronary artery disease and LUCAS compressions could have been stopped. However, the extent of coronary artery disease, namely involvement of the right coronary artery, was not known at the onset of persistent VF and VF did not stop until PCI of the right coronary artery was accomplished.

The potential real-life benefits and drawbacks of this combination have not been examined yet. Our patient suffered a potentially fatal injury to the ascending aorta from the combination of these two devices. The video conclusively demonstrates how the Impella catheter is pushed against the outer aortic curvature by every compression generated by LUCAS. The deflection of the Impella pump caused by the ACCD may lead to tearing of the aortic wall by the Impella's sharp end. In addition, preservation of an optimal Impella position during LUCAS compressions is difficult to achieve as seen in the video.

The combined use of LUCAS and Impella may have disastrous consequences and should carefully be considered if the site has other options for mechanical circulatory support. In case of unknown extent of coronary artery disease at the start of VF, a percutaneous venoarterial extracorporeal membrane oxygenation (ECMO) will better unload both ventricles. ACCD may be continued in such a clinical scenario to avoid left ventricular blood stasis and for better left ventricular unloading despite scarce data for ongoing combined mechanical CPR with extracorporeal CPR (eCPR). In addition, use of an ACCD during cannulation for ECMO support and until start of eCPR is less likely to cause dangerous injuries if the venous cannula is not advanced into the right atrium. ECMO might be a better choice for patients experiencing prolonged cardiac arrest during interventional procedures.

Conflict of Interest
None declared.

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