

Liver Hemorrhage Following Mechanical CPR With the Lund University Cardiopulmonary Assist System (LUCAS) Device: A Focused Case Report

Review began 05/15/2024
Review ended 05/25/2024
Published 05/26/2024

© Copyright 2024

Harb et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Hussein Harb¹, Taimoor Munawar², Hasan Al-Obaidi², Zain Shehzad², Alice Sonnino³

1. Elective Rotations, Ross University School of Medicine, Bridgetown, BRB 2. Internal Medicine, Jamaica Hospital Medical Center, New York City, USA 3. Internal Medicine, Cleveland Clinic Florida, Weston, USA

Corresponding author: Hussein Harb, hussein.harb97@gmail.com

Abstract

Cardiac arrest is a leading cause of mortality globally, and mechanical CPR devices like the LUCAS system are designed to improve outcomes by enhancing consistency and reducing rescuer fatigue. However, this case report of a 76-year-old female who suffered cardiac arrest post-flight reveals significant complications associated with mechanical CPR. Despite achieving initial resuscitation, she developed extensive liver damage and additional complications, which ultimately led to her death. This case underscores the importance of precise training and strict adherence to guidelines when using mechanical CPR devices. It highlights that while these devices offer potential benefits, they also pose risks, especially for vulnerable patients, necessitating careful consideration and ongoing evaluation to optimize safety and effectiveness.

Categories: Gastroenterology, Cardiology, Trauma

Keywords: post-flight cardiac arrest, massive pulmonary embolism, lucas device efficacy, mechanical cpr, emergency resuscitation, liver damage, cardiac arrest management

Introduction

Cardiac arrest is a leading cause of death globally and prompts over a million CPR attempts annually in the United States alone [1]. Mechanical CPR devices such as the LUCAS aim to enhance the consistency and efficacy of CPR, ensure continuous compressions, and reduce physical strain on healthcare providers [2]. However, these devices raise concerns related to their effectiveness in real-world scenarios compared to manual CPR, as well as their potential to cause complications like visceral organ damage [3]. This case report presents the medical journey of a 76-year-old female who experienced a cardiac arrest after a long flight and highlights the potential complications linked with the use of mechanical CPR in emergency medical settings.

Case Presentation

A 76-year-old female with a history of hyperlipidemia, hypertension, and insulin-dependent diabetes was transported to the emergency department following a cardiac arrest after an 11-hour flight. EMS reported that she called for help due to shortness of breath, then suddenly collapsed, developing hypotension and pulseless electrical activity. In the field, Advanced Cardiac Life Support (ACLS) was initiated, including the application of an automated external defibrillator (no shock delivered), 30 minutes of CPR with a LUCAS device, and the administration of seven doses of epinephrine and five doses of midazolam, resulting in ROSC.

Upon ED admission, the patient was hemodynamically unstable, displaying hypotension (blood pressure of 58/32 mmHg), tachycardia (135 beats per minute), and tachypnea (33 breaths per minute), necessitating intubation and ventilation on 100% FiO₂. Neurologically, she responded to pain, exhibited a positive corneal reflex, and had 3/5 bilateral upper extremity strength.

Lab findings included hyperglycemia (497 mg/dL), elevated BUN/Cr (25/1.6 mg/dL), hyponatremia (133 mmol/L), hypokalemia (2.7 mmol/L), an elevated anion gap (22.0), metabolic acidosis (bicarbonate 14 mmol/L), significant transaminitis (ALT/AST 908/809 U/L), lactic acidosis (18.96 mmol/L), and lymphocytic leukocytosis (13.3 x10³/μL).

The electrocardiogram indicated sinus tachycardia with ST depressions in leads V5 and V6 (Figure 1). A chest X-ray showed right upper lobe consolidation. Head and abdominal computed tomography (CT) scans showed no acute changes; leg duplex ultrasonography excluded DVT. A CT chest identified extensive bilateral pulmonary emboli, and an echocardiogram revealed significant right heart dysfunction. Cardiology recommended mechanical thrombectomy for the pulmonary emboli.

How to cite this article

Harb H, Munawar T, Al-Obaidi H, et al. (May 26, 2024) Liver Hemorrhage Following Mechanical CPR With the Lund University Cardiopulmonary Assist System (LUCAS) Device: A Focused Case Report. Cureus 16(5): e61107. DOI 10.7759/cureus.61107

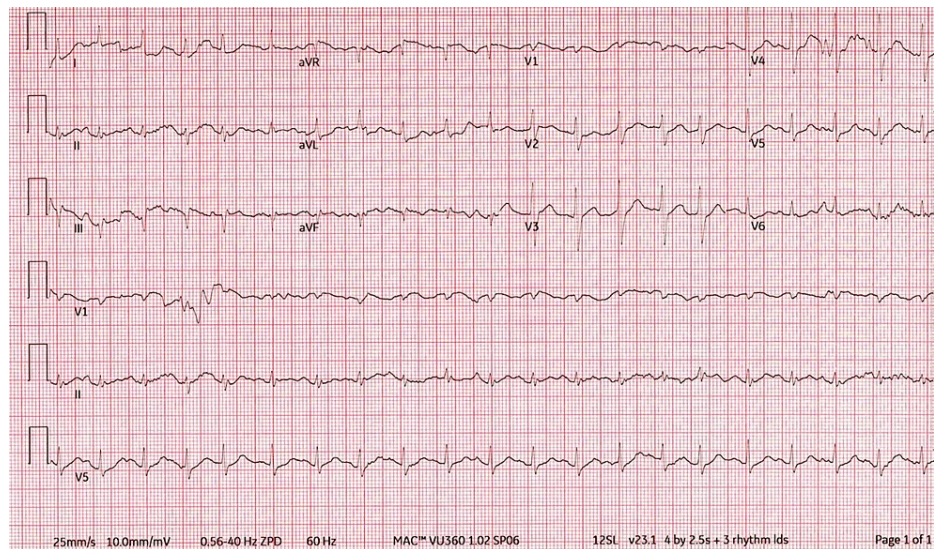


FIGURE 1: 12-lead electrocardiogram showing sinus tachycardia with ST depressions in V5 and V6, occasional premature ventricular complexes, and non-specific ST and T wave abnormalities.

The patient's elevated liver enzymes and creatinine were managed as shock-related liver injury and acute kidney injury, with interventions including an orogastric (OGT) tube, right upper quadrant ultrasound (ordered but not completed), lab monitoring, and hydration. Aspiration pneumonia was suspected based on leukocytosis and chest X-ray findings and treated with piperacillin-tazobactam and vancomycin.

The working diagnosis included cardiac arrest due to pulmonary embolism-related obstructive shock versus sepsis from bilateral aspiration pneumonia with non-ST elevation myocardial infarction (NSTEMI). Treatment included norepinephrine for hypotension, enoxaparin for pulmonary embolism, and pulmonary thrombectomy.

Post-thrombectomy, the patient developed leg swelling, toe cyanosis, and a pulseless right lower extremity. CT angiography suggested a thrombus in the inferior vena cava, but venography confirmed patency. She exhibited a significant hemoglobin drop, indicative of hemorrhage; a source was not identified in the lungs or gastrointestinal tract via bronchoscopy and negative stool guaiac, but guaiac-positive coffee-ground emesis from her OGT was noted.

Her condition worsened with rapid blood pressure drops and free fluid around the liver and left kidney observed on ultrasound. A CT angiogram identified a subcapsular liver hemorrhage (Figure 2), likely venous and possibly secondary to the previous day's CPR by the LUCAS device. Despite transfusions and continued pressurization, she developed a tense, distended abdomen and oliguria, prompting surgical liver packing.

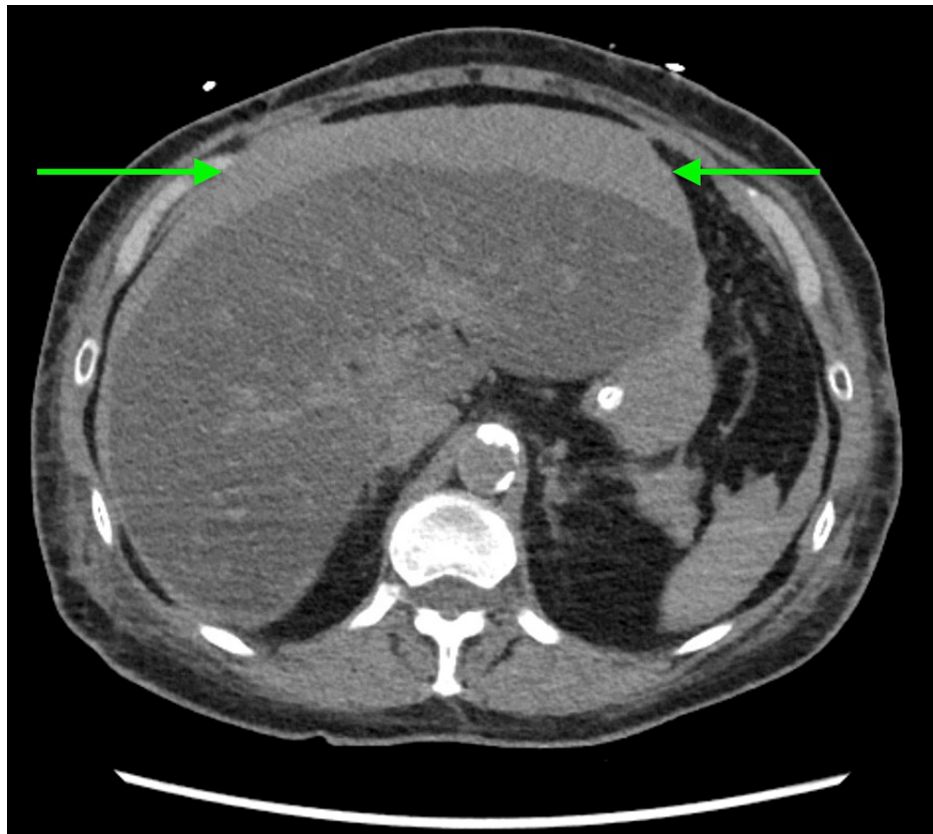


FIGURE 2: CT angiogram depicting perihepatic and capsular hemorrhage with hemoperitoneum layering in the bilateral paracolic gutters and pelvis. The perihepatic/capsular hemorrhage, as indicated by the green arrow, nearly encircles the liver, with areas up to 3 cm thick anteriorly.

Intraoperatively, immediately upon entering the abdomen, the surgeon was able to withdraw four liters of blood. The liver was found to be decapsulated across its entire anterior and superior surfaces. The liver capsule was densely adherent to the opposing peritoneum, resulting in massive hemorrhage (Figure 3). The likely cause of this liver injury was the use of a LUCAS CPR device the previous day. The liver was packed and planned for further resuscitation and surgery within 48 hours. However, the patient experienced a subsequent cardiac arrest in the OR and was pronounced dead after unsuccessful resuscitation efforts.

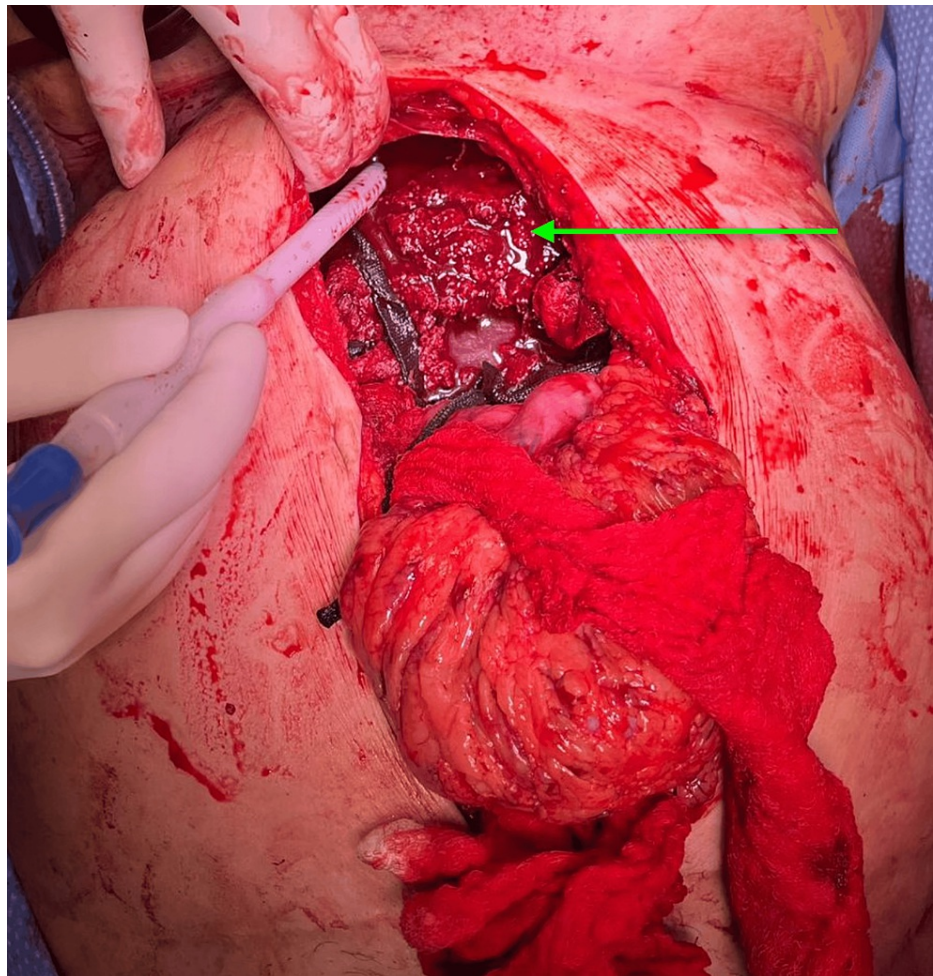


FIGURE 3: Intraoperative surgical procedure image showing extensive hemorrhage from the liver (green arrow) during the liver packing procedure.

Discussion

In the United States, approximately 350,000 cardiopulmonary resuscitation (CPR) attempts occur outside of hospitals annually, with an additional 750,000 attempts in hospitals totaling over a million CPR attempts each year [1]. Despite extensive educational efforts, the quality of in-hospital CPR often remains suboptimal, influenced by factors such as rescuer fatigue during prolonged resuscitation, interruptions in CPR for defibrillation or intubation, and inadequate compression depth and rate [4]. Mechanical chest compression devices, such as the LUCAS, offer a solution by delivering consistent, fixed-rate compressions by American Heart Association (AHA) guidelines [2]. These devices alleviate physical strain on rescuers, potentially improving compression fidelity and minimizing crowding in patient rooms, reducing exposure to aerosolized pathogens. Furthermore, they allow healthcare providers to perform other critical tasks during resuscitation efforts.

Despite evidence indicating that the LUCAS device delivers high-quality compressions consistently, where up to a third of manual compressions may be ineffective [5], studies have not demonstrated a significant difference in patient outcomes between manual and mechanical resuscitation [6-10]. Additionally, a meta-analysis has indicated that mechanical CPR may be associated with an increased risk of complications, such as rib fractures and cardiac or liver injuries, which could result from incorrect placement or migration of the device during use [11]. In this reported case, the patient likely suffered extensive liver damage leading to hemorrhage and eventual death due to improper application of the LUCAS device's compressive mechanism. This underscores the necessity for ongoing, high-quality training of cardiac arrest teams on the correct usage of mechanical CPR devices.

Furthermore, unlike manual CPR, setting up a mechanical CPR device requires additional time, potentially delaying the initiation of life-saving measures during the critical early phase of a cardiac arrest. Yet, studies suggest that with proper training, the time to initiate mechanical resuscitation can be reduced [6].

Current AHA guidelines recommend the use of mechanical CPR devices by trained personnel in situations where high-quality manual compressions are not feasible or could pose a risk to healthcare workers [12]. These guidelines may evolve as increased, high-quality training on mechanical CPR devices potentially results in improved resuscitation outcomes compared to manual ones. A notable case in 2013 involved a 68-year-old male who made a complete recovery from an out-of-hospital cardiac arrest after receiving 59 minutes of mechanical compressions via a LUCAS device, subsequently showing a favorable neurological outcome [13].

Conclusions

This case report highlights the complexities of using mechanical CPR devices, like the LUCAS, in emergency medical scenarios. While such devices offer consistent compression rates and reduce physical strain on healthcare providers, they also present significant risks, as illustrated by the severe liver damage and subsequent death of a 76-year-old patient. This incident underlines the critical importance of proper training and strict adherence to guidelines when using mechanical CPR. It also emphasizes the need for ongoing research to optimize these devices for safety and effectiveness. As these technologies evolve and become more common in resuscitation efforts, continuous updates to clinical guidelines and thorough training for healthcare providers will be essential to balance the benefits of mechanical CPR with its potential risks, aiming to improve survival rates and neurological outcomes for cardiac arrest patients.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Hussein Harb, Hasan Al-Obaidi

Acquisition, analysis, or interpretation of data: Hussein Harb, Hasan Al-Obaidi, Zain Shehzad, Taimoor Munawar, Alice Sonnino

Drafting of the manuscript: Hussein Harb, Hasan Al-Obaidi, Zain Shehzad

Critical review of the manuscript for important intellectual content: Hussein Harb, Hasan Al-Obaidi, Taimoor Munawar, Alice Sonnino

Supervision: Hussein Harb

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. American Heart Association: CPR statistics . (2021). Accessed: May 26, 2024: <https://cpr.heart.org/en/resources/cpr-facts-and-stats>.
2. Canakci ME, Parpucu Bagceci K, Acar N, et al.: Computed tomographic findings of injuries after mechanical and manual resuscitation: a retrospective study. *Cureus*. 2021, 13:e15131. [10.7759/cureus.15131](https://doi.org/10.7759/cureus.15131)
3. Gaisendrees C, Gerfer S, Ivanov B, et al.: Outcomes after mechanical versus manual chest compressions in eCPR patients. *Expert Rev Med Devices*. 2021, 18:1023-8. [10.1080/17434440.2021.1970528](https://doi.org/10.1080/17434440.2021.1970528)
4. Sugerman NT, Edelson DP, Leary M, et al.: Rescuer fatigue during actual in-hospital cardiopulmonary resuscitation with audiovisual feedback: a prospective multicenter study. *Resuscitation*. 2009, 80:981-4. [10.1016/j.resuscitation.2009.06.002](https://doi.org/10.1016/j.resuscitation.2009.06.002)
5. Fox J, Fiechter R, Gerstl P, et al.: Mechanical versus manual chest compression CPR under ground ambulance transport conditions. *Acute Card Care*. 2013, 15:1-6. [10.3109/17482941.2012.735675](https://doi.org/10.3109/17482941.2012.735675)
6. Couper K, Quinn T, Booth K, et al.: Mechanical versus manual chest compressions in the treatment of in-hospital cardiac arrest patients in a non-shockable rhythm: A multi-centre feasibility randomised controlled trial (COMPRESS-RCT). *Resuscitation*. 2021, 158:228-35. [10.1016/j.resuscitation.2020.09.033](https://doi.org/10.1016/j.resuscitation.2020.09.033)
7. Rubertsson S, Lindgren E, Smekal D, et al.: Mechanical chest compressions and simultaneous defibrillation vs conventional cardiopulmonary resuscitation in out-of-hospital cardiac arrest: the LINC randomized trial. *JAMA*. 2014, 311:53-61. [10.1001/jama.2013.282538](https://doi.org/10.1001/jama.2013.282538)
8. Liu M, Shuai Z, Ai J, et al.: Mechanical chest compression with LUCAS device does not improve clinical outcome in out-of-hospital cardiac arrest patients: A systematic review and meta-analysis. *Medicine (Baltimore)*. 2019, 98:e17550. [10.1097/MD.00000000000017550](https://doi.org/10.1097/MD.00000000000017550)

9. Perkins GD, Lall R, Quinn T, et al.: Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial. *Lancet*. 2015, 385:947-55. [10.1016/S0140-6736\(14\)61886-9](https://doi.org/10.1016/S0140-6736(14)61886-9)
10. Hallstrom A, Rea TD, Sayre MR, et al.: Manual chest compression vs use of an automated chest compression device during resuscitation following out-of-hospital cardiac arrest: a randomized trial. *JAMA*. 2006, 295:2620-8. [10.1001/jama.295.22.2620](https://doi.org/10.1001/jama.295.22.2620)
11. Gao Y, Sun T, Yuan D, et al.: Safety of mechanical and manual chest compressions in cardiac arrest patients: A systematic review and meta-analysis. *Resuscitation*. 2021, 169:124-35. [10.1016/j.resuscitation.2021.10.028](https://doi.org/10.1016/j.resuscitation.2021.10.028)
12. Panchal AR, Bartos JA, Cabañas JG, et al.: Part 5: adult basic and advanced life support: 2020 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2020, 142:S366-468. [10.1161/CIR.0000000000000916](https://doi.org/10.1161/CIR.0000000000000916)
13. Zimmermann S, Rohde D, Marwan M, Ludwig J, Achenbach S: Complete recovery after out-of-hospital cardiac arrest with prolonged (59 min) mechanical cardiopulmonary resuscitation, mild therapeutic hypothermia and complex percutaneous coronary intervention for ST-elevation myocardial infarction. *Heart Lung*. 2014, 43:62-5. [10.1016/j.hrtlng.2013.10.011](https://doi.org/10.1016/j.hrtlng.2013.10.011)