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Case Report

Successful Primary Coronary Intervention and Invasive Blood Pressure Monitoring During Lund University Cardiopulmonary Assist System (LUCAS) Mechanical Chest Compression: Case Report

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Abstract

Introduction: Acute ST-segment elevation myocardial infarction demands urgent intervention to restore coronary blood flow, with primary percutaneous coronary intervention (PCI) as the preferred treatment. However, sudden cardiac arrest remains a significant complication, occurring in approximately 1.3% of PCI patients. In such critical situations, delivering high-quality and uninterrupted cardiopulmonary resuscitation (CPR) is a priority. CPR in acute myocardial infarction presents challenges and opportunities when combined with primary PCI. The key to favorable outcomes is immediate resuscitation efforts and timely revascularization of the occluded artery. However, conflict arises between these actions.

Case Report: We report a case of a 54-year-old male patient who suffered an acute myocardial infarction and underwent successful primary PCI with invasive blood pressure monitoring while being in cardiac arrest, as well continuous CPR with the use of the Lund University Cardiopulmonary Assist System (LUCAS), an automated chest compression device. We documented an invasive blood pressure measurement up to 161/69 mmHg during CPR.

Discussion: Manual CPR in catheterization laboratories is challenging due to space limitations and radiation, especially in cases of refractory prolonged cardiac arrest. Mechanical chest compressors are a potential alternative but their efficacy and practicality are still being explored. Simply because arterial cannulation limits blood pressure measurement, there is little thorough evidence on hemodynamic outcomes with mechanical chest compressions.

Conclusion: The evolution of mechanical CPR in catheterization laboratories necessitates ongoing research and clinical guidelines to optimize its application and ensure optimal patient care.

Keywords: acute myocardial infarction, percutaneous coronary intervention, cardiac arrest, mechanical chest compressors, cardiopulmonary resuscitation, invasive blood pressure monitoring

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1. Introduction

Acute ST-segment elevation myocardial infarction (STEMI) is a life-threatening condition that requires immediate medical intervention to restore coronary blood flow. Current guidelines recommend rapid reperfusion therapy, with primary percutaneous coronary intervention (PCI) as the preferred treatment [1]. However, sudden cardiac arrest remains a significant complication, occurring in approximately 1.3% of patients undergoing PCI [2]. In such critical situations, delivering high-quality and uninterrupted cardiopulmonary resuscitation (CPR) is paramount to improving outcomes [3].

Given the dual targets, CPR in cases of acute STEMI poses different challenges as well as opportunities, in particular when combined with primary PCI. The interplay between immediate resuscitation efforts [3] and timely revascularization of the occluded artery [1] is key to favorable outcomes in the context of acute STEMI, where both actions are vital. However, a conflict arises from the need to prioritize effective resuscitation through high-quality CPR while simultaneously addressing the critical requirement for rapid revascularization of the occluded artery in acute STEMI cases [4].

With respect to space limitation and radiation, performing manual high-quality CPR in the catheterization laboratory is a challenging scenario [5], especially in cases of refractory prolonged cardiac arrest. As a result, mechanical chest compressions emerge as a potential alternative yet they raise further questions about efficacy and practicality in such unique logistic situations. Furthermore, the necessity for arterial cannulation limits the use of blood pressure measurement to evaluate the hemodynamic effects of mechanical CPR in clinical practice. Therefore, any comprehensive data about the hemodynamic outcomes (including blood pressure) with mechanical chest compressions are limited.

2. Case Report

The patient was a 54-year-old male with a history of hypertension and myocardial infarction, previously treated with PCI. He presented with mild, central chest pain and shortness of breath during exertion. One day prior to admission, he had experienced severe, crushing chest pain but did not seek medical attention. He denied smoking and alcohol consumption.

Upon arrival, his vital signs indicated hypotension with a blood pressure of 78/50 mmHg, bradycardia with a pulse rate of 55 beats per minute, tachypnoea with a respiratory rate of 32 breaths per minute, a temperature of 37.2°C, and an oxygen saturation level of 90% on room air. Clinical examination was significant for bilateral basal lung crackles. Given these concerning vital signs, immediate fluid resuscitation was initiated, intravenous atropine was administered, and the response to the treatment was closely monitored in addition to the supplementation of oxygen.

A standard 12-leads electrocardiogram was performed, revealing junctional bradycardia, ST-segment elevation in inferior leads, Q wave with poor R wave progression in anteroseptal leads, and ST-segment depression in high lateral leads consistent with acute STEMI (Figure **1**), prompting immediate consideration for primary PCI.

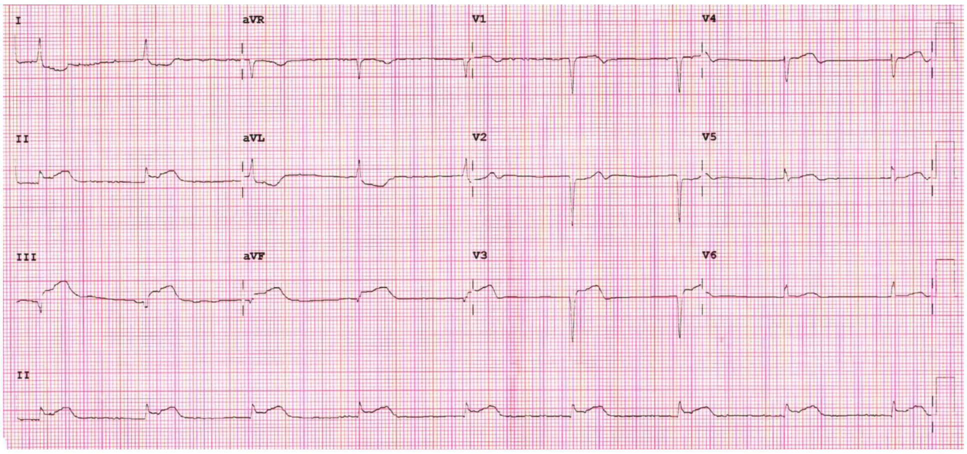

Figure 1: Depicts junctional bradycardia with heart rate of 51 beats per minutes and ST-segment elevation in inferior leads consistent with acute inferior myocardial infarction.

Laboratory tests indicated a high-sensitivity troponin T test of 1,618 ng/L, a creatine kinase MB isoenzyme (CK-MB) mass of 74.4 ng/mL, serum creatinine of 3.0 mg/dL (265.2 μmol/L), serum urea of 80 mg/dL (13.3 mmol/L), lactate of 10.3 mmol/L, serum sodium of 127 mmol/L, serum potassium of 5.6 mmol/L, serum bicarbonate of 14.6 mmol/L, random serum glucose level of 680 mg/dL (37.8 mmol/L), and N-terminal pro B-type natriuretic peptide (NT-proBNP) of 2,297 pg/mL. White blood cell count of 21.0×10^3/uL, a red blood cell count of 5.5×10^6/uL, a hemoglobin of 15.8 g/dL, and a hematocrit of 49.4%.

He was quickly stabilized and transferred to the catheterization laboratory for coronary angiography which revealed a total occlude of the previously stented right coronary artery (RCA), a significant lesion of the proximal left circumflex artery, and a non-significant lesion of the previously stented left anterior descending artery (Figure **2**).

Shortly after starting the coronary angiogram, the patient progressed to cardiac arrest with ventricular fibrillation, necessitating up to five electrical defibrillations (Figure **3**). He was managed according to the advanced cardiac life support pathway, which included invasive mechanical ventilation. Subsequently, the rhythm then altered to pulseless electrical activity (PEA), hence manual external chest compression started initially, followed by LUCAS mechanical chest compression right through the CPR. Ultimately, the return of spontaneous circulation could not be achieved and, unfortunately, he was declared deceased after 80 minutes. During the CPR with LUCAS mechanical chest compression, PCI to RCA could be accomplished and the flow could be restored to the occluded vessel (Figure **2**).

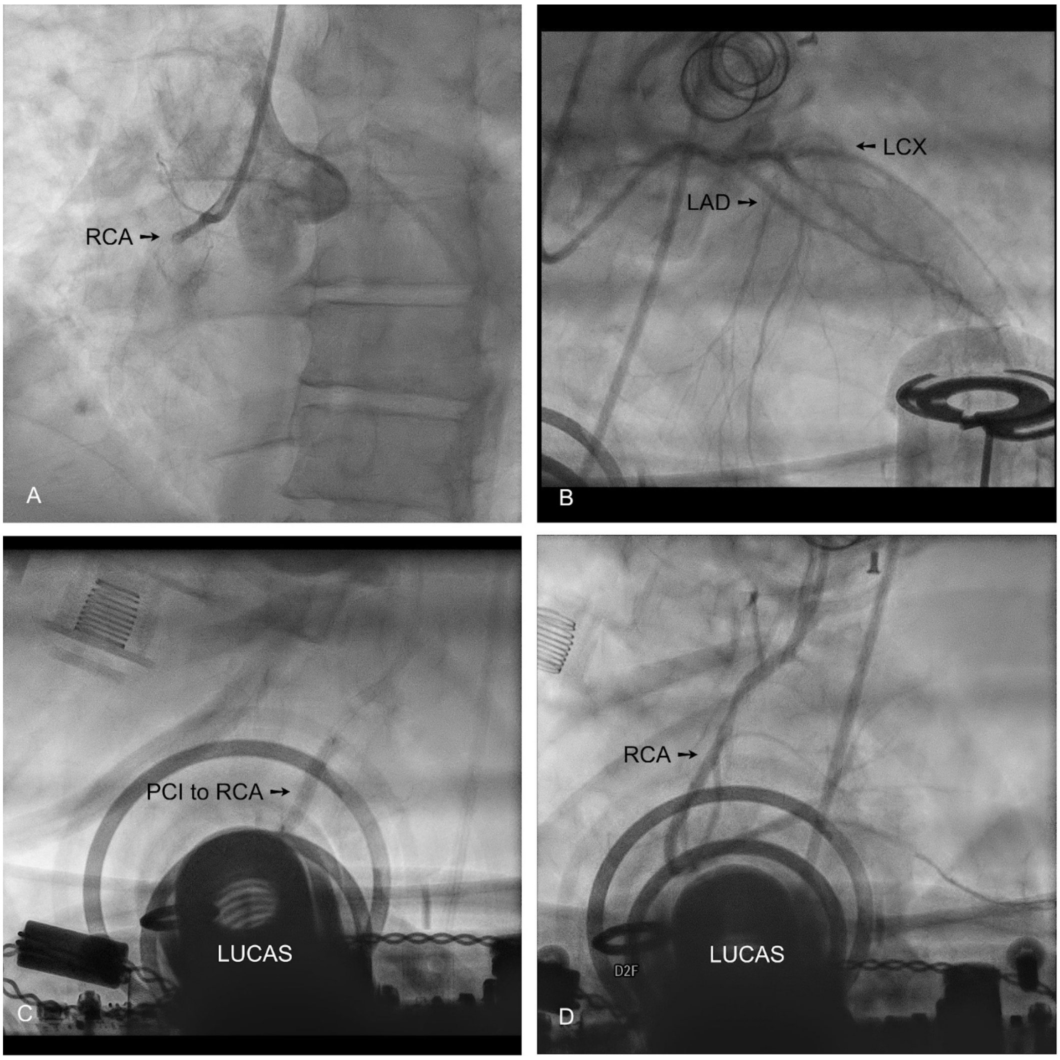

Figure 2: A. Coronary angiogram shows total block of right coronary artery (RCA). B. Coronary angiogram of left coronary system. C. Primary percutaneous coronary intervention (PCI) during Lund University Cardiopulmonary Assist System (LUCAS) chest compression. D. The flow is restored to the RCA.

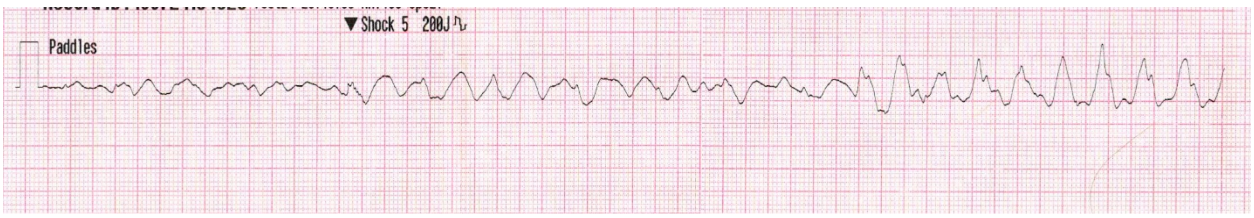

Figure 3: Shows the ventricular fibrillation and the fifth electrical defibrillation during the CPR.

The LUCAS device could generate a proper hemodynamic response all through the CPR, as demonstrated by the invasive blood pressure measurement through the radial arterial sheath up to 161/69 mmHg (Figure **4**).

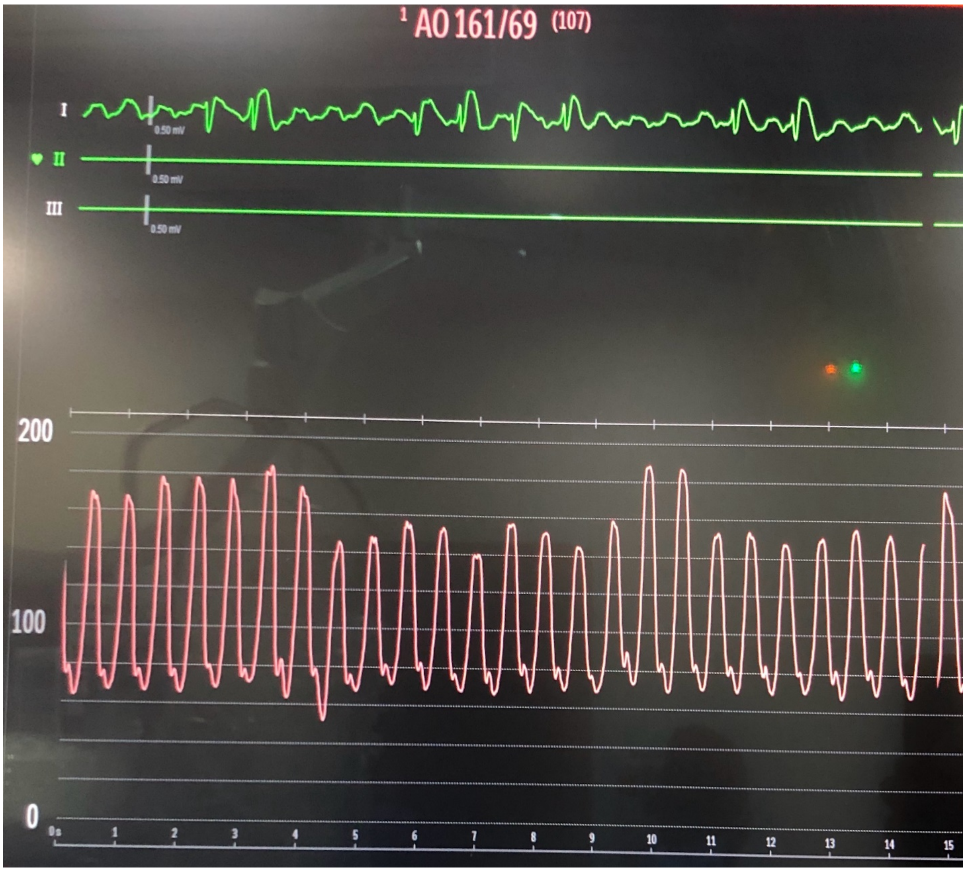

Figure 4: Shows blood pressure arterial waveform during the CPR demonstrates a blood pressure measurement up to 161/69 mmHg with average mean arterial pressure (MAP) of 107 mmHg.

3. Discussion

The debate between CPR during acute STEMI and primary PCI centers on the balance between immediate resuscitation and revascularization urgency. Healthcare providers must strike a balance between reviving a patient and restoring blood flow to the occluded artery [1, 3], as failure can lead to severe complications. Timely intervention and high-quality CPR strategies are crucial for improving patient outcomes. Mechanical chest compression devices in catheterization laboratories offer high-quality chest compressions without interruptions and fatigue [5], allowing rescuers to focus on other resuscitation tasks. Though there are potential risks [6], the integration of mechanical CPR with catheterization laboratory procedures allows for uninterrupted resuscitation while addressing the underlying coronary occlusion, which is often the precipitating factor in cardiac arrest during acute STEMI [7]. This approach not only supports hemodynamic stability but also enhances the likelihood of successful revascularization, probably improving the likelihood of survival and discharge [8]. Additionally, these devices improve the rate of the return of spontaneous circulation, particularly in STEMI patients where coronary artery occlusion is the underlying cause of cardiac arrest [8].

Extracorporeal membrane oxygenation (ECMO) has become a vital intervention for managing refractory cardiac arrest, especially in STEMI patients unresponsive to conventional CPR. Combined with primary PCI, known as extracorporeal cardiopulmonary resuscitation (ECPR) [9], ECMO offers full circulatory support, enabling myocardial rest and controlled PCI procedures [10]. Although resource-intensive and limited to specialized centers, ECMO has demonstrated encouraging outcomes in survival and neurological recovery, particularly for in-hospital cardiac arrest cases [9, 10]. Recent data shows no significant association between patient movement for ECPR cannulation and improved outcomes, with a non-significant 30% reduction in odds (P = 0.62) [11].

Invasive blood pressure monitoring during the CRP is not usually practical. However, a noninvasive method of prediction of blood pressure generated by chest compressions to monitor the quality and efficacy of CPR is feasible [12]. A limited number of studies (mainly case reports and series) comparing manual CPR with mechanical devices have shown improved blood pressure with mechanical compressions [13]. However, the impact on long-term survival and neurological outcomes varies across the studies. The utilization of these devices into the care practice for patients with cardiac arrest undergoing primary PCI could enhance the neurological outcomes by ensuring that cerebral perfusion is maintained until definitive coronary intervention can be achieved [14]. In our report, we clearly demonstrated an adequate hemodynamic outcome in terms of invasive blood pressure measurement, generated by LUCAS mechanical chest compressions.

Survival rates following cardiac arrest show marked variation based on the initial heart rhythm. Patients presenting with a shockable rhythm have significantly higher survival rates (32.6%) compared to those with a non-shockable rhythm (11.4%) [15]. The unadjusted probability of survival is approximately five times greater for those with a shockable rhythm, as indicated by an odds ratio of 4.672 (95% CI: 3.578–6.100; P < 0.001) [15]. These results highlight the critical importance of the initial rhythm in determining outcomes.

Although successfully revascularized, our patient had cardiac arrest with prolonged PEA (non-shockable rhythm), which might be linked to the poor prognosis in addition to the extensive myocardial ischemia. Nonetheless, given that this is a single case report, we are unable to conclude that hemodynamic response to the mechanical chest compression devices is constantly adequate. The evolution of mechanical CPR in catheterization laboratories necessitates ongoing research and clinical guidelines to optimize its application and ensure optimal patient care.

4. Conclusion

Utilizing mechanical chest compressors in refractory cardiac arrest improves emergency medical response efficiency and effectiveness, ensuring proper hemodynamic response and emphasizing the need for technological advancements in the cardiology field for more successful coronary interventions.

Acknowledgments

None.

Statement of Ethics

This case report complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

Ethical Approval

Ethical approval was not required for this case report in accordance with the MBRU-Institutional Review Board (MBRU-IRB) policies.

Patient Informed Consent Statement

Written informed consent for publication of the case report and any accompanying images was obtained from the patient's next of kin (Son) as the patient is deceased.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Artificial Intelligence (AI) Disclosure Statement

AI-unassisted work.

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Author Contributions

Sadeq Tabatabai developed the concept, wrote the manuscript, edited the images, and was involved in the patient management. Ali Khalifeh collected the data and reviewed the manuscript. Jasem Mohammed

Alhashmi was involved in patient management and reviewed the manuscript. All authors read, reviewed, and approved the final manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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