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CASE REPORT
Coronary heart disease

ECMELLA: successful rescue cardiopulmonary support in post-coronary artery bypass graft cardiogenic shock with cardiac arrest—case report

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Background Cardiogenic shock is the main cause of death in hospitalized patients with acute coronary syndromes, with a high mortality rate. The management of graft thrombosis after coronary artery bypass graft (CABG) surgery is challenging and the best revascularization strategy is not well defined. In patients who develop cardiac arrest due to graft thrombosis, the benefits of mechanical support during advanced cardiac life support are uncertain. Rescue extracorporeal cardiac bypass resuscitation has been used in the context of cardiopulmonary arrest, with survival rates of around 34.7% of which 28.5% with good neurological outcome.

Case summary We present here the case of a patient who developed cardiogenic shock after CABG graft occlusion. The patient suffered refractory cardiac arrest during percutaneous revascularization and received rescue cardiopulmonary support. Revascularization was achieved and there was a successful resuscitation with the placement of venous-arterial extracorporeal membrane oxygenation (VA-ECMO) and an Impella CP device. After a 29-day hospitalization the patient was discharged with no neurological sequelae.

Discussion Although there is limited evidence of the benefit of a combined use of mechanical support (VA-ECMO with other mechanical devices) in the management of cardiogenic shock and cardiac arrest following CABG surgery, there seems to be a lower mortality with this approach, and possibly more favourable neurological outcomes. Further research is needed to elucidate the advantages of Impella vs. intra-aortic balloon pump combined with VA-ECMO in such patients.

Keywords Cardiogenic shock • Coronary revascularization • Haemodynamic support • Case report

Learning points

- There is limited evidence of the benefits of a combined use of mechanical support (venous-arterial extracorporeal membrane oxygenator with other mechanical devices) in the management of cardiogenic shock and cardiac arrest following coronary artery bypass graft surgery. However, there seems to be a lower mortality with this approach, and possibly more favourable neurologic outcomes.
- In refractory ventricular fibrillation cardiac arrest with poor left ventricle functioning Impella could be a viable alternative to intra-aortic balloon pump.
- More research is needed to compare outcomes of a combined use of mechanical haemodynamic support in this context.

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Introduction

Cardiogenic shock is the main cause of death in hospitalized patients with acute coronary syndromes.[1] The management of graft thrombosis after coronary artery bypass graft (CABG) surgery is challenging and the best revascularization strategy is not well defined.[2,3] In patients who develop cardiac arrest due to graft thrombosis, the benefits of mechanical support during advanced cardiac life support (ACLS) are uncertain.[4,5] Rescue extracorporeal cardiac bypass resuscitation has been used in the context of cardiopulmonary arrest, with survival rates of around 34.7% of which 28.5% with good neurological outcome.[6,7]

Timeline

Time	Event	Action
Day 0	Double coronary artery bypass graft (CABG): left internal mammary artery to left anterior descending (LAD) and right internal mammary artery to marginal artery	
	Haemodynamic instability at the end of procedure	Repeat CABG: saphenous vein graft to distal LAD
	Hypotension with electric instability on arrival to intensive care unit (ICU)	Percutaneous coronary intervention (PCI) due to hyperacute graft occlusion: angioplasty with stent implantation at the origin of the LAD
	Cardiac arrest (ventricular fibrillation) during PCI	Immediate advanced cardiac life support (no-flow time 0 min)
		Venous-arterial extracorporeal membrane oxygenation (VA-ECMO) and Impella were placed (low-flow time 55 min)
	Transferred to ICU on target control temperature protocol	
	Low urinary output	Renal replacement therapy: continuous venovenous haemodiafiltration (CVVHDF)
Day 3	Pneumonia (*Haemophilus influenzae*)	Antibiotic (empirically with piperacillin–tazobactam and linezolid for 5 days; targeted antibiotic with amoxicillin-clavulanic acid for another 5 days)
Day 5	Withdrawal of CVVHDF	
Day 6	Removal of VA-ECMO	
Day 8	Removal of Impella	Bleeding in the left femoral artery during Impella removal, with surgical repair, that evolved into a local infection
Day 10	Withdrawn from ventilator and extubated	
Day 13	Left inguinal wound infection (*Serratia* spp.)	Targeted antibiotic with meropenem for 5 days
Day 19	Discharged from ICU with no neurological sequelae	
Day 29	Transferred to other hospital	

Case presentation

In this article, we report the case of a 39-year-old male patient, with a medical history of ischaemic cardiopathy, hypertension, dyslipidaemia, and obesity. The patient suffered from worsening exertional dyspnoea, exams revealed advanced coronary disease and was proposed for an elective surgical coronary revascularization.

On physical examination, the patient presented with exertion to minor efforts, without other findings. Electrocardiogram in sinus rhythm, with a complete left bundle branch block. Laboratory findings were within normal range.

Pre-operatory coronary angiography revealed three-vessel disease: 70–90% stenosis in the proximal segment of the left anterior descending artery (LAD), 70–90% stenosis in the medial segment of the left circumflex artery with total distal occlusion, and 91–99% stenosis of the first marginal artery (MA) and total occlusion of the right coronary artery. An echocardiographic evaluation showed severe dilation and poor functioning left ventricle (LV)—end-diastolic volume 453 mL, estimated ejection fraction 35%. Right ventricular functioning was preserved—tricuspid annular plane systolic excursion 17 mm.

The patient was given on-pump double CABG surgery—left internal mammary artery to LAD and right internal mammary artery (RIMA) to MA. Due to haemodynamic instability at the end of the

procedure with an ST-segment elevation in the anterior electrocardiogram derivations, repeat CABG was performed with a saphenous vein (SV) graft to the distal LAD artery.

Immediately after transfer to the intensive care unit (ICU), the patient's haemodynamic status deteriorated with frequent premature ventricular complexes and hypotension. The patient was immediately transferred to the coronary angiography room on suspicion of hyperacute graft occlusions of both bypasses from the SV to LAD and RIMA to MA. Angioplasty was performed with successful stent implantation at the origin of the LAD artery. During the procedure, a ventricular fibrillation (VF) cardiac arrest occurred. Advanced cardiac life support was successfully performed with a mechanical compression device (LUCAS 2) for 55 min, refractory to defibrillation, amiodarone, and lidocaine. Simultaneously, he was connected to a veno-arterial extracorporeal membrane oxygenation (VA-ECMO) circuit and an Impella CP device was placed through the left femoral artery, and intraventricular position confirmed under fluoroscopy and VF ceased. These devices were placed after a failed attempt at inserting an intra-aortic balloon pump (IABP). During the procedure, there was an accidental tear of the left femoral artery, with important bleeding, controlled with surgical repair.

After being transferred to the ICU, the patient remained sedated, with invasive mechanical ventilation support, and perfusions of noradrenaline, adrenaline, and dobutamine. Median artery pressures were above 80 mmHg with peripheral signs of hypoperfusion. Because of low urinary output and signs of volume overload, renal replacement therapy was initiated with continuous venovenous haemodiafiltration.

Both mechanical and pharmacological support were maintained for approximately a week. Venous-arterial extracorporeal membrane oxygenator was used with a maximum circuit flow of 4 L/min and a fraction of inspired oxygen (FiO_2) of 100% for 2 days, then down-titrated to a minimum of 2.5 L/min circuit flow, maintaining an FiO_2 of 100%. With recovery of LV function, weaning from VA-ECMO was possible, and it was finally removed on Day 6. Continuous venovenous haemodiafiltration was suspended on Day 5, with full recovery of renal function during the following days. Impella was set at P7 with an output of 2.7 L/min for 3 days, then downgraded to P5 with an output of 1.7 L/min and removed on Day 8. High doses of noradrenaline (max: 0.77 µg/kg/min), adrenaline (max: 0.31 µg/kg/min), and dobutamine (max: 6.45 µg/kg/min) were used until Day 5, then progressively down-titrated and finally suspended on Day 14. The patient was withdrawn from ventilatory support and extubated on Day 10, without complications.

Despite the good haemodynamic and respiratory progression, there were some complications.

On Day 3, the patient developed pyrexia and increased laboratory inflammatory parameters. Both *Haemophilus influenzae* isolated in bronchi secretion samples and thoracic radiography images suggested pneumonia. Empiric antibiotic treatment was initiated with piperacillin–tazobactam 4.5 g 8/8 h and linezolid 600 mg 12/12 h for 5 days, downscaled to amoxicillin-clavulanic acid 1.2 g 8/8 h for another 5 days with full resolution.

There were concerns about possible anoxic encephalopathy in the early days of admission. The patient remained on targeted temperature management aimed at temperatures under 36°C for 24 h, then warmed according to the local protocol. Neurological recovery was observed with a Glasgow Coma Scale of 15 points, with no sensitive or motor deficits. However, there was marked muscular weakness due to critical illness polyneuropathy. The patient received rehabilitation care with a physiotherapist from Day 7 in the ICU and then in the ward.

On Day 19, the patient was finally transferred from the ICU to the medical ward and, after a total of 29 days in our hospital with no neurological sequelae, was discharged to another hospital near his hometown. After 7 days, the patient was sent home, keeping regular rehabilitation sessions. Two months later he was able to take daily 30 min walks and climb two staircases without significant dyspnoea.

Discussion

Cardiogenic shock is the main cause of death in hospitalized patients with acute coronary syndromes and mortality rates still reach as high as 50–60%.[1]

In the case described, the patient suffered an early graft occlusion, which is known to occur in up to 10% of saphenous grafts. He presented haemodynamic instability, which can be the form of presentation in 3–6% of patients.[2] The patient was first given a repeat CABG surgery, followed by percutaneous coronary intervention (PCI). Revascularization strategy for early graft occlusion is not well defined, as either repeat CABG or balloon angioplasty (with or without stenting) can be used.[3]

Patients with perioperative ventricular arrhythmias have a significant increase in postoperative mortality.[4] In this case, the patient had a VF cardiac arrest during PCI and received rescue cardiopulmonary support. There is still ongoing debate about using mechanical support during ACLS because of its uncertain benefits. However, coronary revascularization was achieved and there was a successful resuscitation with mechanical automatic compressions during VA-ECMO cannulation.

A meta-analysis comparing manual with mechanical automatic compression devices reported higher rates of return to spontaneous circulation in patients who underwent automatic compression. Nevertheless, there are no survival benefits.[5]

Rescue ECMO resuscitation was used in the setting of cardiopulmonary arrest (eCPR). Venous-arterial mode was chosen because of pre-existing LV dysfunction. The eCPR survival rate is estimated to be 34.7%, of which 28.5% with a good neurological status.[6] Cerebral hypoxia and neurological injury are known complications associated with ECMO.[7] Despite having a low-flow period of 55 min, our patient had a favourable evolution, without any neurological deficit.

Little is known about the benefits and outcomes of combining other mechanical circulatory support with ECMO. In the case presented, a combined mechanical strategy was used, adding an Impella to VA-ECMO. Intra-aortic balloon pump placement with VA-ECMO is our standard practice, but this approach was not successful due to the persistence of VF and haemodynamic instability. After attempting this, an Impella CP was therefore placed, with adequate perfusion. Although IABP has been the gold standard for mechanical circulatory support for decades, there is no benefit in terms of 30-day mortality.[8] Recently introduced percutaneous ventricular assist devices such as the Impella bring different haemodynamic effects and clinical

applicability. Unlike the IABP, which decreases LV pressures and increases stroke volume, Impella pumps blood from the LV into the aorta, thus unloading the LV, therefore decreasing cardiac workload, myocardial oxygen consumption, and demand.[9] Another advantage of Impella in this case was that the support provided with this device was not dependent on a stable heart rhythm, unlike IABP. Nevertheless, no significant mortality difference has been found between these two devices, with mortality rates ranging from 35% to 54%.[10,11] Because VA-ECMO may increase LV afterload, a combined strategy, using either IABP or Impella might be beneficial. The mortality reported seems to be lower using combined therapy (54% vs. 65%); however, neurological, gastrointestinal, and limb-related complications do not differ significantly.[12–14]

Conclusion

With this case report, we emphasize the importance of prompt rescue cardiopulmonary support when there is cardiogenic shock and cardiac arrest following post-CABG graft occlusion. Although there is limited evidence of the benefits of a combined mechanical support (VA-ECMO with other mechanical devices), there seems to be a lower mortality with this approach, and possibly more favourable neurological outcomes. In patients with poor LV function and VF cardiac arrest, the use of Impella, instead of an IABP combined with VA-ECMO, may be considered in future cases. However, further research is needed to elucidate the advantages of the Impella in such patients.

Lead author biography

Zara Chan Nogueira is graduated from Medical University of Lisbon in 2014. Currently, she is Resident in the Anaesthesiology Department, Hospital Santa Maria, Centro Hospitalar Universitário Lisboa Norte, Lisbon, Portugal.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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