The successful use of the Impella RP after a long cardiopulmonary resuscitation and systemic thrombolytic therapy in a patient with a fulminant pulmonary embolism: the first case report

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Abstract

Acute massive pulmonary embolism (PE) can result in progressive cardiogenic shock, right heart failure, and respiratory failure requiring cardiopulmonary resuscitation (CPR). We report the case of a 56-year-old woman who required prolonged CPR secondary to a highly suspected massive PE and cardiogenic shock. After receiving preclinical thrombolytic therapy, the patient was transferred to the intensive care unit with ongoing CPR. Because of persistent haemodynamic instability and acute right ventricular failure, an Impella RP was successfully implanted and immediate haemodynamic improvement was observed. Absent any contraindications, the Impella RP should be considered a feasible alternative in patients with acute right ventricular failure due to pulmonary embolism.

Keywords

Pulmonary embolism • Acute right ventricular failure • Impella RP • Cardiopulmonary resuscitation • Case report

Introduction

Seventy percent of cardiac arrests are due to either acute myocardial infarction or pulmonary embolism (PE).1 Pulmonary embolism is a major cause of mortality, morbidity, and hospitalization in Europe. The main mechanism of sudden cardiac death after PE is acute right heart failure due to pressure overload.2 The acute right ventricular failure is potentially reversible, and early acute management can be life-saving,3 since the right ventricle (RV) is more resilient than the left.4 The early administration of thrombolytic therapy during out-of-hospital cardiopulmonary resuscitation (CPR) can improve outcomes and increase the chances for a return of spontaneous circulation (ROSC) for patients in whom PE is highly suspected.3

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† The first two authors contributed equally to the production of this case.
Mechanical circulatory support in patients with acute right ventricular failure can be helpful, but is not generally recommended due to the existence of limited data.\textsuperscript{5,6} We report a case of a patient successfully failed CPR and preclinical systemic thrombolytic therapy for a suspected fulminant PE. CPR and preclinical systemic thrombolytic therapy for a suspected massive PE. A 56-year-old female patient was admitted to the intensive care unit (ICU) with ongoing CPR after more than 1 h of out-of-hospital CPR and preclinical systemic thrombolytic therapy for a suspected massive PE.

### Timeline

| Timing       | Relevant data |
|--------------|---------------|
| Day 0/Hour 0 | - Emergency Call |
|              | - Initiating CPR during patient transportation because of collapse |
|              | - Application of Metalysis due to highly suspected fulminant PE |
| Day 0/Hour 1 | - Arrival at ICU under ongoing CPR |
|              | - Echocardiographically massive RV-Dilatation |
| Day 0/Hour 3 | - Implantiing Impella RP for hemodynamic stabilisation |
| Day 0/Hour 4 | - Major Bleeding occurred requiring 5 erythrocyte concentrates, 4 units of fresh frozen plasma, 4 units of PPSB and 2 units of fibrinogen |
| Day 1        | - Initiating continuous veno-venous hemofiltration because of anuria and metabolic triggers |
| Day 5        | - Successfull Impella-Weaning and Explantation |
| Day 9        | - Extubation |
| Day 43       | - Transfer to a gastro-enterologic center because of persistent gastric ulcers and complicated enteral feeding |

Mechanical circulatory support in patients with acute right ventricular failure can be helpful, but is not generally recommended due to the existence of limited data.\textsuperscript{5,6} We report a case of a patient successfully stabilized by the implantation of a percutaneous circulatory support device (Impella RP) after more than 1 h of out-of-hospital CPR and preclinical systemic thrombolytic therapy for a suspected massive PE.

### Case presentation

A 56-year-old female patient was admitted to the intensive care unit (ICU) with ongoing CPR after an out-of-hospital cardiac arrest. At the time of admission, CPR had already been performed for 60 minutes. The initial emergency call was made because of severe dyspnoea. The patient relayed a several week history of a respiratory infection, with corresponding respiratory difficulty, and had been physically inactive. She had completed a course of antibiotics (cefodoxime) seven days prior to call, and had suffered from diarrhoea since the cessation of the antibiotics. Furthermore, she suffered from essential thrombocythaemia taking hydroxyxcarbamide for several years.

A few minutes after the emergency call the ambulance arrived at the patient’s home. They found the patient severely dyspneic, cyanotic, and marbled with an initial peripheral oxygen saturation of 70% and tachycardia (heart rate 134 b.p.m.). During transportation to the ambulance the patient suffered a complete cardio-pulmonary collapse and CPR was initiated using a chest compression system (LUCAS CPR). Furthermore the patient was intubated and mechanical ventilation was started. Systemic thrombolytic therapy (60,000 units of tenecteplase) was administered due to the high suspicion of pulmonary embolism. On the way to the hospital, a few seconds of ROSC occurred followed by resumption of CPR. The patient arrived at the hospital under resuscitation, with continuing CPR in the ICU for another 20 min (initial pH value 6.8, lactate 19 mmol/L). After administering of high dose catecholamines (adrenaline 0.23 μg/kg/min, noradrenaline 0.8 μg/kg/min) a permanent ROSC was reached, but the patient was still haemodynamically unstable. Initial physical examination revealed equal pupils both reacting to light similarly, a remarkable congestion of the jugular veins and signs of cardiogenic shock with blood pressure (BP) of 85/46 mmHg and tachycardia (134 b.p.m.); no other pathologies were noted. Echocardiography revealed massive dilatation of the RV with D-shape, paradoxical movement of the ventricular septum and McConnell’s Sign (Figure 1).\textsuperscript{7} Furthermore, there was no sign of a thrombus in the pulmonary artery (PA) or right ventricular outflow tract. The initial pulmonary embolism severity index (PESI) was determined to be 226 points (Class V, very high risk) predicting a 10–24.5% 30-day mortality. The diagnosis of fulminant PE was made by clinical and echocardiographic findings. Initial laboratory parameters revealed D-Dimer > 80 mg/L FEU (<0.5 mg FEU/L), hs troponin T of 335 ng/L (< 14 ng/L), creatinine initially of 122 μmol/L (<80 μmol/L), and thrombocytes of 237 Gpt/L (150–370 Gpt/L).

Because of haemodynamic instability a chest computed tomography (CT) was not a reasonable option and because of the prolonged duration of CPR, signs of end-organ failure and previous application of systemic thrombolytic therapy with expected high-bleeding risk, extracorporeal support was not considered appropriate. The patient was taken to the cardiac catheterization laboratory for implantation of an Impella RP. The Impella RP was implanted through the right femoral vein and advanced to the left PA with a right-sided cardiac output support of 3.5 L/min (Figures 1 and 2). The patient’s haemodynamic condition stabilized immediately after device implantation, allowing a decrease in the norepinephrine dosage to 0.3 μg/kg/min. The patient was subsequently weaned from the epinephrine drip 2 hours after implantation of the Impella RP. Therapeutic hypothermia, with a target temperature of 33°C for 24 h, was initiated after the patient’s return to the ICU. Heparin was administered intravenously with a target activated clotting time of 160–180 s during the use of the Impella RP. Upon return to the ICU, haemorrhage was noted at the insertion site, as well as a large (12 cm × 12 cm) femoral haematoma. The haemoglobin dropped from initial 5.00 mmol/L to 2.50 mmol/L (normal range 7.45–6.96 mmol/L). Clotting times (pTT, Quick INR, fibrinogen, and thrombine time) were not possible to measure. This was likely caused by the previous in-field administration of thrombolytic therapy and the heparin used during the Impella RP implantation as well as heavy dilution because of volume loading. Haemostasis was achieved at the bedside with direct pressure to the insertion site and administration of additional clotting factors (1200 mL of fresh frozen plasma, 2000 IE of prothrombin complex, 2 units of fibrinogen). Furthermore, 5 units of blood (300 mL each) had to be administered. There was no hint for arterial-venous fistula, aneurysm spurium, or intraabdominal haematoma at the insertion site. The bleeding stopped after transfusion and compression. Because of anuria, metabolic acidosis (pH value 7.21, base excess -9.7 mmol/l) and hyperkalaemia (potassium 5.7 mmol/L) continuous veno-venous haemofiltration dialysis was initiated at Day 1. Duplex sonography of
both lower extremities revealed bilateral deep-vein thromboses. During mechanical haemodynamic support through the Impella RP daily echocardiographic assessments for the position of the microaxial-pump, RV-function and right ventricular end-systolic pressure (RVESP) were implemented. Furthermore, laboratory parameters to screen for potential haemolysis (lactate dehydrogenase, bilirubin, haptoglobin, free haemoglobin) were obtained daily, no signs for haemolysis were noted. After haemodynamic stabilization and an improvement of right ventricular function, the Impella RP was weaned after 5 days and removed without any further device-related complications. The patient was extubated on day 9 of hospital stay. There were no signs for hypoxic brain damage.

The patient was very weak during the first days after extubation so intermittent non-invasive ventilation was needed but the respiratory situation stabilized and the patient was able to ambulate. Furthermore, haemodialysis was weaned successfully after 40 days. The right ventricular function improved significantly reaching normal values on discharge. Unfortunately her stay was complicated by gastirc paresis and multiple gastric ulcers as well as stenotic ischaemic proctitis. She was unable to make the transition to a normal enteral diet, suffered from rectal pain, and required multiple gastroenterologic interventions. She was transferred to a gastroenterological centre for further therapy 43 days after hospital admission. After another 37 days of stay within the gastroenterologic centre, the rectum was dilated and the ulcers healed. She was referred to an angio-logic expert for follow-up. The patient was completely clear of any indications of deep-vein-thrombosis (DVT) by 46 days post CPR. As per post-DVT protocol, therapeutic oral anticoagulant with a new oral anticoagulant therapy was initiated with recommended continuation for at least 1 year. Neoplastic screening revealed no malign disease. The patient was released from the gastroenterologic centre into a neurologic rehabilitation clinic because of critical illness myopathy where she stayed for three weeks. Afterwards, the patient was discharged to home. As of 4 months after neurological rehabilitation (7 month after CPR) the patient is at home and fully recovered and ambulatory. She had another proctitis which leads to the application of a temporary anus prater and is actually awaiting another surgery for anus prater relocation.

Discussion
Cardiac arrest due to PE still has a high mortality. Haemodynamic compromise in these patients can lead to the need for mechanical haemodynamic support, but thus far no consensus procedure has been established. Evidence supporting the use of veno-venous extracorporeal membrane oxygenation (vv-ECMO) in patients with acute PE is limited to animal-model experiments and human case reports/series.6 A haemodynamic benefit of mechanical right ventricular assist in patients with acute right ventricular failure has been shown previously but only for patients after LVAD-implantation, myocardial infarction, post-cardiotomy, or post transplantation.7 However, the presence of a current PE or a thrombus in the right atrium (RA), RV, or PA was considered a contraindication to the use of a right ventricular assist device in the mentioned study.7 To our knowledge, there is only one prior case report describing the use of the Impella RP in a patient with an acute PE. The patient in that case report arrested during postoperative hospitalization. Pulmonary embolism was confirmed by chest CT. There was no previous prolonged CPR or systemic thrombolytic therapy applied.8 To the best of our knowledge, our
case report is the first employing an Impella RP device after prolonged CPR and the administration of thrombolytic therapy in a patient with PE and acute right ventricular failure. Because our patient required prolonged CPR and demonstrated signs of end-organ failure, vv-ECMO was not considered appropriate. In the present case, the patient’s haemodynamic status immediately stabilized after implanta-
tion of the percutaneous assist device. We were able to wean the patient from the Impella RP and the device was removed after 5 days with significant improvement of right ventricular function. Because of haemodynamic instability and high clinical likelihood of PE, CT perfu-
sion imaging was not considered ostensible in the acute situation. The diagnosis was made by typical patients symptoms (severe dyspnoea, hypoxia, cardiogenic shock), risk factors (inactivity due to a respiratory infect, diarrhoea and dehydration as well as essential thrombocythe-
tia), and clinical findings (massive RV-dilatation with typical echocar-
diographic signs for pulmonary embolism, deep vein thrombosis in both legs).

A computerized tomography perfusion imaging scan was per-
formed two weeks after the initial incident. Unfortunately, the diag-
nosis PE could not be confirmed. A total resolution of the thrombus
was assumed due to preclinical systemic thrombolytic therapy and therapeutic anticoagulation.

The use of a percutaneous right ventricular assist device may repre-
sent a feasible alternative to ECMO-support in patients with acute right ventricular failure due to PE who have contraindications for ECMO. Particularly in patients with end-organ failure due to progressive shock or prolonged CPR, the application of a less invasive device such as the Impella RP can reduce both the risk of access site bleeding and the systemic inflammatory response. The latter is often observed in patients with ECMO. Also, Impella RP implantation is faster and more simple than ECMO, and its use in not limited to specialized centres.

Conclusions

To the best of our knowledge, this is the first case report describing the use of the Impella RP after CPR in a patient with acute right ven-
tricular failure from a massive PE. Although the presence of a throm-
bus in the RA, RV, or PA is considered a reasonable contraindication for the placement of a percutaneous device into the right ventricular outflow tract, we believe that the Impella RP can provide good mechanical support in patients with acute right ventricular failure due to PE who have required CPR. Further studies are needed to evaluate the optimal application of percutaneous right ventricular mechanical haemodynamic support.

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.

Author Contributions: A.S. and A.Y. were involved in compilation of data and writing of this piece. G.E. and K.I. were lead consultants/
senior authors involved in the management of the case.

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