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Case report

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PII: S0959-289X(17)30009-2
DOI: http://dx.doi.org/10.1016/j.ijoa.2017.01.003
Reference: YIJOA 2530

To appear in: *International Journal of Obstetric Anesthesia*

Received Date: 5 October 2016
Revised Date: 19 December 2016
Accepted Date: 3 January 2017

Please cite this article as: McDonald, C., Laurie, J., Janssens, S., Zazulak, C., Kotze, P., Shekar, K., Successful provision of inter-hospital extracorporeal cardiopulmonary resuscitation for acute post-partum pulmonary embolism, *International Journal of Obstetric Anesthesia* (2017), doi: http://dx.doi.org/10.1016/j.ijoa.2017.01.003

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Successful provision of inter-hospital extracorporeal cardiopulmonary resuscitation for acute post-partum pulmonary embolism.

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ABSTRACT

Mortality during pregnancy in a well-resourced setting is rare, but acute pulmonary embolism is one of the leading causes. We present the successful use of extracorporeal cardiopulmonary resuscitation (eCPR) in a 22-year old woman who experienced cardiopulmonary collapse following urgent caesarean section in the setting of a sub-massive pulmonary embolism. Resources and personnel to perform eCPR were not available at the maternity hospital and were recruited from an adjacent paediatric hospital. Initial care used low blood flow extracorporeal membrane oxygenation (ECMO)

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with pediatric ECMO circuitry, which was optimised when the team from a nearby adult cardiac hospital arrived. Following ECMO support, the patient experienced massive haemorrhage which was managed with utero-tonic agents, targeted transfusion, bilateral uterine artery embolisation and abdominal re-exploration. The patient was transferred to an adult unit where she remained on ECMO for 5 days. She was discharged home with normal cognitive function. This case highlights the role ECMO plays in providing extracorporeal respiratory or mechanical circulatory support in a high risk obstetric patient.

Introduction

Severe acute pulmonary disorders, such as thromboembolic disease, aspiration, pulmonary edema and amniotic fluid embolism can occur during pregnancy and the peripartum period.[1-3] Cardiorespiratory failure, refractory to conventional treatment, may arise and lead to cardiac arrest. The incidence of acute respiratory failure during pregnancy is reported as less than 1 in 1000, while cardiac arrest is 1 in 30,000.[1, 4] Implementation of timely advanced cardiac life support (ACLS) procedures is paramount but not always sufficient. The use of extracorporeal cardiopulmonary resuscitation (eCPR) may be the only method to establish meaningful cardiorespiratory support until the underlying issues of acute cardiopulmonary failure can be addressed. We report the successful provision of inter-hospital eCPR after prolonged post-partum hemodynamic compromise.

Case History

A 22-year old pregnant female at 36 weeks of gestation presented to a regional hospital following a two day history of dyspnea. Past medical history included only treated hypothyroidism. She was hypoxic on room air (PaO_2 87%), tachycardic (140 beats/min) with a metabolic acidosis (pH 7.31) and an elevated lactate (3.8 µmol/L) suggestive of tissue hypoperfusion. Transthoracic echocardiography (TTE) at the referring hospital had indicated significant right to left septal deviation with obvious right heart strain but no visible left atrial or pulmonary trunk clot. CT pulmonary angiography indicated central pulmonary emboli (PE) with segmental and sub-segmental branches bilaterally (Figure

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1). After deliberation the patient was given 8000U heparin and transferred to the tertiary maternity hospital.

Cardiotocography demonstrated fetal tachycardia with shallow decelerations followed by a prolonged bradycardia prompting a decision to perform an emergent caesarean section (CS) under general anaesthesia resulting in the delivery of a profoundly acidotic female infant who did not survive. After wound closure hemodynamic instability prompted the start of ACLS, but despite good quality ACLS and sporadic reversion to sinus rhythm and output, spontaneous circulation could not be established. The nearby adult extracorporeal life support (ECLS) centres were unable to provide timely eCPR, and the ECLS team at the neighboring pediatric hospital (located 500 m away) was alerted. Thrombolytic therapy using the recombinant tissue plasminogen activator tenecteplase 50mg (Metalyse, Boehringer Ingelheim Pty Ltd. North Ryde 2113) was commenced 60 min after initiating CPR.

The pediatric surgical and perfusion team arrived 65 min after CPR had started. While CPR continued, surgical exposure of the femoral artery and vein was performed. An 8 mm graft was sewn side to end on the femoral artery and a 21Fr multistage cannula (Medtronic. Minneapolis, MN. USA) was inserted in the femoral vein. Extracorporeal membrane oxygenation (ECMO) support using a pediatric ECMO PLS circuit (MAQUET Getinge, Rastatt. Germany) began 100 min after CPR commencement and 35 min after the perfusion team arrived in the OR. Due to the smaller pediatric circuit, initial ECMO circulatory support was limited to approx 2 L/min, and this was changed to an adult ECMO circuit (Maquet PLS and RotaFlow) when the adult ECLS team arrived, permitting ECMO blood flows of 3.6 L/min.

Although transfer to the adult cardiothoracic surgical centre for further management was planned, persisting haemdynamic instability prevented early transfer.

Emergency Venoarterial (VA) ECMO restored organ perfusion but unmasked an acquired coagulopathy following prolonged CPR with organ failure which was worsened the thrombolytic agent. Attempted correction of coagulopathy was guided using

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thromboelastography (TEG®), and active management with uterotonic agents, uterine balloon tamponade and bilateral uterine artery embolization via the right brachial artery was performed. Continued bleeding with abdominal distension required transfusion of red cells and other blood products including fibrinogen concentrate (CSL Behring, USA) (see table 1). A repeat laparotomy evacuated 3 L of fresh blood from the abdominal cavity, which was processed through a cell-saver and returned to the patient. No uterine bleeding source was identified, but bleeding was identified in the rectus muscles and hemostasis was achieved prior to wound closure. Hysterectomy was not performed due to concerns it would precipitate further hemorrhage.

Approximately 14 h after CPR had begun, the patient was transferred by road to the intensive care unit at the local adult cardiothoracic hospital. Pulmonary embolectomy, possibly with an ECMO based right ventricular device, was planned, but the patient stabilized on VA ECMO and was not required. ROTEM® and Multiplate® (Tem Innovations GmbH, Switzerland) were performed on arrival, revealing a lengthened clotting time with low fibrinogen and significant platelet dysfunction. The local transfusion protocol using platelets and cryoprecipitate was followed, which normalized clotting within 24 h. ECMO was weaned on day 5.

On day 1 post-ECMO the patient developed a deep vein thrombosis (DVT) in the right common femoral vein and inferior vena cava (IVC). DVT prophylaxis was commenced and an IVC filter inserted on day 2 post-ECMO. Additional complications during admission included: right arm compartment syndrome requiring fasciotomy and repair due to brachial artery bleed following removal of arterial sheath, sepsis of unknown origin treated with broad spectrum antibiotics and antifungals, renal and hepatic dysfunction, and repeat laparotomy to evacuate a haematoma. The uterus was found to be intact with no necrosis.

On day 9 post-ECMO the patient was transferred back to the tertiary obstetric hospital. She was subsequently discharged home with normal cognitive function, a persistent right foot drop and a right flexion contracture of the upper limb post fasciotomy. She remained

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on anticoagulation following IVC filter removal 3 months post partum and menses returned. Thrombophilia screening was negative.

Discussion

This case describes the successful use of ECMO initiated during CPR (eCPR) in the setting of postpartum PE, complicated further by rapid deterioration of the clinical condition following caesarean delivery, the lack of evidence based guidelines and the provision of inter-hospital eCPR.

ECMO has been described for cardiorespiratory support in the peri- and post-partum period, most commonly to treat adult respiratory distress syndrome secondary to influenza A (H1N1).[5, 6] Some case studies describe the successful use of ECLS following post-partum cardiovascular collapse.[7-9]

ECLS (ECMO and eCPR) are increasingly used to provide extracorporeal respiratory support and /or mechanical circulatory support (MCS) in patients for whom conventional treatments are inadequate. ECMO outcomes for patients at high risk of dying are improving, and a variety of MCS devices exist; detailed information on these devices and perfusion techniques is available elsewhere.[10-12]

The case presented had the hallmarks of a poor outcome, including prolonged CPR (>90 min) and non-availability of ECMO equipment. Survival rates above 70% are reported following use of ECMO in non-pregnant patients, but decrease to 50% if ECMO is initiated for massive PE requiring CPR.[3] Additionally, in the general population the use of eCPR has a poor survivability (<30%) which is dependent on many factors including length of CPR before ECMO and in-hospital vs out of hospital CPR.[13, 14]

Massive PE with haemodynamic compromise in non-pregnant patients is managed with anticoagulation and thrombolysis.[15] There are few evidence-based guidelines to assist decision making in near term pregnancy with sub-massive PE and subsequent fetal hypoxia.[16] In our patient, thrombolysis was initially avoided due to an anticipated

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surgical delivery, but was started following delivery. Even when delivery is not anticipated, there is concern that thrombolytic therapy may lead to placental abruption, although this has not been reported. In the absence of clear guidelines the management of PE (including thrombolysis) during pregnancy should be individualized.

This case raises several organizational issues. Extracorporeal life support therapies are resource intense and there may be volume outcome relationship associated with their use.[17] ECLS is generally restricted to specialist hospitals with retrieval services which stabilize critically ill patients on ECMO prior to transfer to the ECLS centre. The use of ECLS is likely to increase and more patients will have access to this technology in future. While it is not practical (and probably ineffective) to provide wide spread ECLS services or to provide an emergency retrieval response, clinicians should consider ECLS for patients with high risk of cardiorespiraory deterioration and liaise early with nearby specialist centres. Patient selection may be difficult with limited evidence for ECLS therapies.

This case highlights that, despite evidence suggesting a likely poor outcome, the restoration of cardiopulmonary circulation, aggressive control of bleeding and ECMO management at an established centre, a favorable outcome was possible.

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Table 1: Blood product utilisation

RBC- red blood cells; FFP- Fresh Frozen Plasma; Cryo- Cryoprecipitate; Plt- Platelets; Proth- Prothrombinex; Fib- Fibrinogen concentrate; ECMO- Extracorporeal Membrane Oxygenation

Figure 1. CT pulmonary angiography (CTPA) depicting central pulmonary emboli

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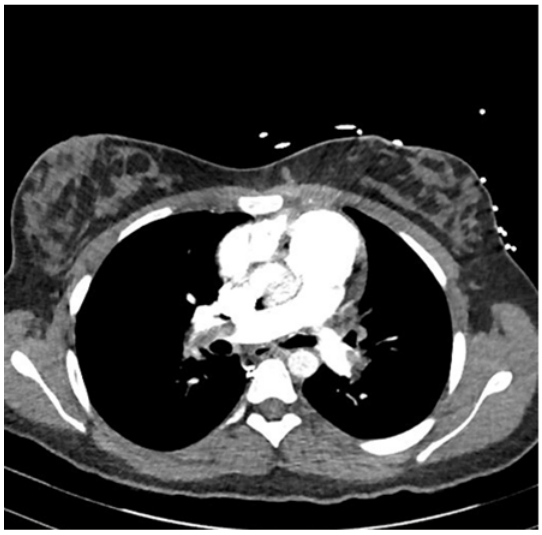

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	RBC	FFP	Cryo	Plt	Proth	Fib
Pre-ECMO	16	9	40	2	500Iu	
ECMO	17	0	5	6		1
Total products	33	9	45	8	500IU	1

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Highlights.

- *Considering ECLS in high risk obstetric patients undergoing planned procedures or in those presenting with obstetric emergencies*
- *Understanding the haemostatic challenges in this patient population especially when ECLS is initiated in the post partum setting. .*
- *Recognizing the potential for successful outcomes in a patient population where the mortality associated with acute PE, amniotic embolism or an acute reversible or decompensated chronic cardiomyopathy is high.*

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