Cesarean section in the setting of severe pulmonary hypertension requiring extracorporeal life support

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Abstract We describe the use of veno-arterial extracorporeal membrane oxygenation (ECMO) in a 35-year-old female with severe fixed pulmonary hypertension who went into cardiogenic shock during a Cesarean section. Pregnancy in the presence of severe pulmonary hypertension is typically contraindicated due to high maternal mortality rates. This patient visited our hospital at 37 weeks of gestation after experiencing dyspnea and chest pain. Clinical evaluation revealed severe fixed pulmonary hypertension. At the time of the planned delivery, femoral lines were placed; in case of emergency, ECMO became necessary during the delivery. During delivery, the patient developed sudden hemodynamic collapse necessitating rapid cannulation and initiation of ECMO. She was stabilized pharmacologically and separated from ECMO after 2 days. The baby was delivered uneventfully, and the mother and child were discharged 1 month after delivery.

Keywords Cesarean section · Pulmonary hypertension · ECMO

Introduction

Pregnancy in the presence of severe fixed pulmonary hypertension (PAH) is contraindicated due to high maternal mortality. Increased circulating blood volume and the hypercoagulability of pregnancy in the presence of PAH result in maternal mortality rates between 30 and 50% [1]. Since pregnancy with PAH presents such a significant risk, Cesarean section is recommended, although this adds potential anesthetic risk. Given the acute blood volume shifts during Cesarean section, it is reasonable to utilize extracorporeal membrane oxygenation (ECMO) support for pregnant patients with reduced cardiac, cardiopulmonary, or pulmonary function associated with increased peripartum risk [2]. Overall, survival of pregnant patients with severe cardiopulmonary failure due multiple conditions using ECMO is 80% [3]. Here, we report the successful use of ECMO for cardiogenic shock occurring during Cesarean section due to severe PAH.

Case report

A 35-year-old African-American female (gravid 2, para 1) at 37 weeks of gestation was admitted to our obstetrics department after experiencing dyspnea, chest pain, and near syncope. Her past medical history was significant only for gastroesophageal reflux disease and her previous delivery was vaginal and uncomplicated. At presentation, her blood pressure (BP) was 108/70 mmHg, heart rate was 85 beats/min, and respiratory rate was 14/min. Transthoracic echocardiography (TTE) revealed normal left ventricular systolic function (ejection fraction 55%), and septal motion consistent with elevated right ventricular pressure and volume overload. Right heart catheterization quantified the cardiac index at 2.88 L/min/m², pulmonary artery pressure at 106/35 mmHg (mean 62 mmHg), and pulmonary capillary wedge pressure at 10 mmHg, consistent with severe PAH (Table 1). She was transferred to the Cardiac Care Unit (CCU) and an
epoprostenol (PGI₂) drip was initiated at 5 ng/kg/min. Her pre-operative chest X-ray shows enlargement of the pulmonary artery and her contrast-enhanced CT angiogram of the chest (right) shows marked dilation of the central pulmonary arteries with prominent peripheral pulmonary vessels (Fig. 1).

Cesarean section under epidural anesthesia with ECMO standby was planned. Prior to incision, single-lumen 16 g femoral arterial and venous lines were placed percutaneously via a modified Seldinger technique. Starting central venous pressure (CVP) was 2–4 mmHg and mean arterial pressure (MAP) was 70 mmHg (Table 1). Immediately after delivery of the infant from the uterus, the MAP dropped to 40 mmHg, heart rate increased to 120–130 beats/min, and oxygen saturation began to drop. Epinephrine, norepinephrine, and vasopressin were initiated for refractory hemodynamic instability and persistent increase in CVP to 15 mmHg. The patient was intubated and heparin was administered systemically. Femoral lines were rapidly exchanged for a 21 Fr venous cannula and a 16 Fr arterial cannula, and emergent veno-arterial (VA) ECMO was initiated at a flow rate of 3.7 L/min [Quadrox oxygenator (Maquet)]. The patient remained hemodynamically stable on-ECMO in the OR and the Cesarean section was completed by the obstetrics team with uneventful surgical hemostasis. The patient was transferred to the CCU where she was weaned off inotropic drips, and mechanical support was maintained at 3.2–4 L/min. Heparin infusion was continued with a PTT target of 40–60.

Table 1 Cardiac function and hemodynamics

<table>
<thead>
<tr>
<th></th>
<th>5 days pre-ECMO</th>
<th>on-ECMO</th>
<th>After decannulation</th>
<th>2 months after ECMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV function</td>
<td>Normal LV function</td>
<td>Severe global hypokinesis</td>
<td>Borderline global function</td>
<td>Normal LV function</td>
</tr>
<tr>
<td>FS (%)</td>
<td>49.5</td>
<td>6</td>
<td>52.4</td>
<td>57.4</td>
</tr>
<tr>
<td>RV function</td>
<td>Mild global hypokinesis</td>
<td>Severe global hypokinesis</td>
<td>Mild global hypokinesis</td>
<td>Mild global hypokinesis</td>
</tr>
<tr>
<td>RV size</td>
<td>Severely dilated</td>
<td>NA</td>
<td>Moderately dilated</td>
<td>Severely dilated to 90</td>
</tr>
<tr>
<td>PAP systolic (mmHg)</td>
<td>105</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other findings</td>
<td>No MR</td>
<td>Moderate MR</td>
<td>Trace MR</td>
<td>Trace MR</td>
</tr>
<tr>
<td>ABG*</td>
<td>pH 7.37, pCO2 36 mmHg, pO2 129 mmHg, HCO3 20 mEq/L</td>
<td>pH 7.34, pCO2 45 mmHg, pO2 110 mmHg, HCO3 23 mEq/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECMO flow</td>
<td>3.2–4 L/min</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* ABG performed 6 h after ECMO cannulation/decannulation

Fig. 1 Chest X-ray (left) shows enlargement of the pulmonary artery. Contrast-enhanced CT angiogram of the chest (right) shows marked dilation of the central pulmonary arteries with prominent peripheral pulmonary vessels.
TTE on postoperative day 1 demonstrated improved right ventricular function. The patient received intravenous furosemide and continued on inhaled nitric oxide and intravenous epoprostenol at 7 ng/kg/min. On postoperative day 2, ECMO flows were decreased due to maintenance of systolic BP, heart rate, and CVP and marked right ventricular improvement on TTE. The patient was taken to the operating room for decannulation and primary repair of her right femoral artery. She recovered uneventfully and discharged 1 month after delivery. Her child was healthy with a normal APGAR score.

Postoperative workup revealed the etiology of pulmonary hypertension was likely idiopathic pulmonary hypertension Group 1. The patient’s rheumatology workup, chest tomography, chest tomography for pulmonary embolism, and Schistosomiasis IgG were negative, and her pulmonary capillary wedge pressure, pulmonary function tests, thyroid function tests, hemoglobin electrophoresis, and scleroderma antibody (Scl-70) were all within normal limits.

Discussion

Physiological changes of pregnancy include increased circulatory volume, which occurs slowly over the course of gestation. During delivery, volume shifts secondary to blood loss and relief of IVC compression acutely alter cardiac preload, which can cause acute RV decompensation in patients with severe PAH, resulting in high maternal mortality rates (30–50%) [1]. This has led to the general recommendation against pregnancy in the setting of severe PAH. Cesarean section is the recommended method of delivery, because it eliminates the potential for uncontrolled vaginal hemorrhage and the adverse hemodynamic effect of bearing down, but it remains a high-risk procedure in patients with severe PAH [1, 4].

There have been multiple reports on the use of ECMO in pregnancy. In a recent systematic review [3], 67 pregnant and postpartum women were supported with ECMO, the majority of whom received veno-venous (VV) support for acute respiratory distress syndrome (ARDS). Indications for VA ECMO include ARDS with hemodynamic instability, peripartum cardiogenic shock, and amniotic fluid embolism. Overall, maternal and fetal survival with ECMO were 80% for VV ECMO and 70% for VA ECMO. In another recent systematic review [5], the maternal and fetal survival rates of all reported cases of extracorporeal life support during pregnancy were 77.8 and 65.1% respectively. Katsuragi et al. described 42 pregnant women with PAH who were divided into [1] mild PAH (systolic PABP ≥ 30 and <50 mmHg on echocardiography or mean PABP ≥ 25 and <40 mmHg by catheterization) and [2] severe PAH (systolic PABP ≥ 50 mmHg on echocardiography or mean PABP ≥ 40 mmHg by catheterization) [6]. Patients with severe PAH delivered earlier and had higher rates of small-for-gestational-age infants and lower New York Heart Association (NYHA) class dropped, whereas among the women with mild PAH, almost all patients remained in the same class. Regarding the timing of ECMO initiation, patients with an expected high risk of cardiac shock should be scheduled for Cesarean section with cardiac anesthesia and ECMO standby. Pre-delivery placement of lines for rapid guidewire exchange facilitates rapid stabilization and prevents the potential complications that can occur with systemic anticoagulation and initiation of extracorporeal support prior to delivery.

In conclusion, a Cesarean section with VA ECMO support was successfully performed in a patient with severe PAH with a short recovery period before separation from mechanical support. In such cases where cardiogenic shock is anticipated, advance preparation for ECMO utilization can improve patient outcomes.

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Compliance with ethical standards

Conflict of interest All authors have no conflict of interest.

References