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Use of Cardiopulmonary Bypass for Management of Massive Air Embolism During Hysteroscopic Metroplasty

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Abstract: The patient was a 32-year-old woman who presented with infertility secondary to uterine didelphys. Hysteroscopic metroplasty was chosen as the corrective surgical procedure for this anatomical defect. During the surgical repair, the patient developed a massive air embolism (MAE) leading to hypotension, arrhythmia, and cardiogenic shock. Resuscitation was started by placing the patient in the right-side up position, and emplacement of central venous catheter, but it was unsuccessful. The decision was then made to bypass the patient's cardiopulmonary system to effectively treat the MAE. Cannulation was done via femoral vein and artery. During cardiopulmonary bypass (CPB), the MAE was quickly eliminated, oxygen saturation was normalized, and the patient was hemodynamically stabilized. The surgical repair was successfully completed and the patient was decannulated and recovered without any incident.
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Operative hysteroscopy is a minimally invasive surgical technique, commonly used in treating intrauterine pathology. Although considered to be a safe technique, there is a 0.8% risk of gas embolism (1). This event could cause morbidity and in serious cases may even lead to death (2). In case of large uterine venous sinuses, air could enter the systemic venous circulation (3). The term gas embolism generally refers to air embolism; however, the use of other medical gases, such as nitrogen, nitrous oxide, and carbon dioxide, carry similar risks (4). Incision of noncollapsed veins and the presence of subatmospheric pressure in these vessels trigger the entry of gas into the venous system. This causes a pressure gradient between the point of gas entry and the right side of the heart. Also, a dangerous pressure gradient can be creates as a result of high infusion pressure. More than 3 mL/kg of intravenous air is required for significant clinical effects. This will lead to outflow obstruction, decreased pulmonary venous return, and subsequent decreased left ventricular preload and cardiac output (5). Therefore, massive air embolism (MAE) has to be immediately treated to avoid the risk of cardiogenic shock (6).

Herein, we present a rare case of MAE resulting from a surgical correction of uterine didelphys using hysteroscopic metroplasty technique. When all other resuscitative attempts failed, emergent cardiopulmonary bypass (CPB) was implemented.

DESCRIPTION

The patient was a 32-year-old woman, with no significant medical history. The patient's height, weight, and body surface area were 165 cm, 60 kg, and 1.66 m^2, respectively. She was admitted for treatment of a 10-year known infertility secondary to uterine didelphys. She had a history of two premature labors, completely septate uterus, and polycystic ovary syndrome. Consequently, she underwent laparoscopic ovarian cystectomy and hysteroscopic metroplasty. At the end of the hysteroscopic procedure, the patient's oxygen saturation decreased suddenly from 98% to 70% in less than 1 minute. Due to human error, air bubbles entered in the tube of the irrigant solution, so air embolism was suspected. As the patient was in lithotomy position, she was immediately turned supine and was placed in the trendelenburg position and tilted onto the right-side up position and ventilated with 100% oxygen. Simultaneously, the patient became bradycardic with

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a heart rate of 30–40 beats per minute and developed ST elevation with oxygen saturations of 45–50%. Systolic blood pressure decreased from 130 to 80 mmHg.

Two bolus doses of atropine, 0.6 and 0.5 mg, respectively, were injected to treat bradycardia. Despite the increased heart rate from 35 to 48 beats per minute, the patient experienced a 16 mmHg drop in systolic blood pressure. Subsequently, ephedrine (single bolus, 1 mg) was administered intravenously to treat hypotension. As oxygen saturation remained low, a 7-F central venous catheter (Arrow International, Boston, MA) was inserted to assist with air evacuation. The patient subsequently developed ventricular fibrillation and required defibrillation to establish a normal sinus rhythm. We used Zoll M Series Biphasic defibrillator (Zoll Medical Corp., Chelmsford, MA). During resuscitation, the following medications were also administered: dexamethasone (16 mg), methylprednisolone (1 g), mannitol 10% (350 mL), and furosemide (10 mg) were given in a 20-minute period. Urine output during the procedure was 12 mL/kg/h. According to emergency condition, we did not have any blood gas before CPB. During CPB, blood gas results were pH: 7.26 mmol/L; Pco2: 37 mmHg, Po2: 357 mmHg; base excess: −8 mmol/L; O_2 saturation: 100%, Hb: 9 g/dL, Hct: 27g/dL; Hco3:17 mEq/L.

Unresponsive to resuscitative measures, the patient remained hypotensive and hemodynamically unstable, so the cardiac surgery team was consulted. As a salvage effort to evacuate the MAE, the cardiac surgeon decided to bypass the patient's cardiopulmonary system. The patient's right femoral vein and artery were cannulated using 24-F and 19-F percutaneous heparin-coated cannula (Edwards, Irvine, CA), respectively. Then percutaneous cardiopulmonary support (PCPS) was immediately started. The PCPS system consisted of a S3 roller pump (Stockert, Germany), Dideco venous reservoir, and hollow fiber membrane oxygenator (Dideco, Milan, Italy). Under PCPS, huge amount of air was evacuated through femoral vein drainage cannula. After 10 minutes of PCPS, the patient's electrocardiogram was normalized, and oxygen saturations improved to 98%. Both cannulas were removed and the patient was subsequently disconnected from the CPB machine.

The CPB prime consisted of standardized solution of ringer, heparin 100 U/kg, 25% mannitol 0.5 mg/kg. Gas setting was FiO_2 100%. Temperature was 37°C. Heparin 400 U/kg was given as anticoagulant and each 100 unit of heparin was reversed by 1 mg of protamine.

Once resuscitated, the patient was extubated, regained consciousness with normal gag and swallow reflexes, and responded appropriately to verbal commands (Glasgow Come Scale = 13–14). Hemodynamically stable and without neurological deficits the patient was then transferred to the intensive care unit. She had an uneventful recovery and was discharged 1 month later. Approximately 2 years postoperatively, the patient successfully conceived without complication and delivered a healthy baby.

COMMENT

One of the catastrophic complications of operative hysteroscopy is MAE. The air could enter into the circulation during hysteroscopic surgery, because of the exposed uterine veins. Depending on the detection method, its incidence may vary from 10% to 50% (1,7). In the last decade, by the advent of liquid distension medium, the probability of gas embolism has faded away. Nevertheless, the potentially lethal cardiovascular and neurological risks make this a relatively dangerous surgical procedure (8).

There are some imperative interventions for treatment of gas embolism. Corrective interventional maneuvers include 1) maintaining circulation, 2) using volume expanders, and 3) preventing further gas entry. Once symptoms of MAE are observed, the affected patient must be immediately placed into left lateral decubitus (right-side up) position to prevent right ventricular outflow obstruction by airlock. In cases of MAE, central venous catheter placement may be necessary to effectively evacuate air. Administration of up to 100% oxygen can decrease bubble size by establishing a diffusion gradient that favors gas elimination (9).

In our case, although these interventions were done carefully, they were not effective. Fortunately, the CPB machine acted miraculously as a life saver and rescued the patient. The importance of CPB machine in a successful management of these situations must not go unnoticed. This procedure may also be applicable in any kind of MAE during endoscopic procedures.

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