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Perioperative management of emergent cesarean section in a patient with peripartum cardiomyopathy and orthopnea: a case report

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Abstract

Perioperative management of pregnant women with heart failure is difficult. Management of anesthesia in pregnant women is especially difficult because all of the currently available choices present challenges. We report a patient with peripartum cardiomyopathy (PPCM) who required an emergent cesarean section and discuss the possible tactics for managing anesthesia. A 40-year-old primipara with severe cardiac and respiratory failure required an emergent cesarean section at 39^{+1} gestational weeks. Her left ventricular ejection fraction was between 10% and 15%, and she had orthopnea. General anesthesia was planned after inserting sheaths for percutaneous cardiopulmonary support from the femoral artery and vein. However, when the patient was asked to lie down on the operation bed, she panicked and resisted because of labor pain and dyspnea. Therefore, anesthesia was induced instead of the initial plan. Finally, we successfully managed the anesthesia and delivered the newborn. There are no alternatives to general anesthesia in patients with PPCM presenting with orthopnea. Anesthesia induction in the supine

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position is impossible in such patients owing to dyspnea. Anesthesia should be started with light sedation in the sitting position, and ketamine or low-dose remifentanil may be an option to maintain maternal hemodynamics and prevent neonatal asphyxia.

Keywords
Anesthesia, sitting position, peripartum cardiomyopathy, pregnancy, cesarean section, extracorporeal membrane oxygenation

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Introduction

Peripartum cardiomyopathy (PPCM) is a rare disease presenting with idiopathic heart failure during the peripartum period.[1] Clinicians engaging in perioperative care face challenges in the selection of anesthetic methods and postoperative management of pregnant women with heart failure. We report our experience of a patient with PPCM who had an emergent cesarean section and discuss the currently available anesthesia induction methods.

Case report

This case report was written in accordance with the CARE guidelines.[2]

A 40-year-old primipara (body weight, 56 kg; height, 151 cm) was transferred to the emergency room of our hospital because of severe heart and respiratory failure at 39^{+1} gestational weeks. Although she had a history of autoimmune hemolytic anemia at 29 years old and diffuse large B-cell lymphoma with complete remission after chemotherapy (R-CHOP regimen comprising cyclophosphamide, doxorubicin hydrochloride [hydroxydaunorubicin], vincristine sulfate [Oncovin], and prednisone) at 35 years old, she did not have a history or a family history of cardiac disease. She did not have a smoking history. She was taking oral prednisolone (2.5 mg).

The patient developed leg edema at 37 gestational weeks and dyspnea at 38^{+5} gestational weeks. However, she did not visit a prenatal clinic. At 39 gestational weeks, she visited her physician one night for exacerbation of symptoms. She was immediately transferred to our hospital for severe dyspnea. At the time of admittance, she was in the first stage of labor, her cervix was dilated by 5 cm, and she was experiencing frequent uterine contractions. Cardiotocography showed moderate baseline variability (5–10 beats/minute [bpm]), tachysystole (uterine contractions: 1–1.5 minutes apart), and severe variable decelerations (Figure 1a). She was in an agitated state because of labor pain and dyspnea. The pulse oximeter saturation was approximately 90% under an oxygen mask with a reservoir. Although pulse oximeter saturation was recovered to 100% using bilevel positive airway pressure, she had orthopnea. Her systolic blood pressure and heart rate were 110 to 120 mmHg and 150 bpm, respectively (Figure 1b). A chest X-ray showed pulmonary edema (Figure 1c) and echocardiography demonstrated diffuse hypokinesis of the left ventricle (LV) with a reduced LV ejection fraction (LVEF) at 10% to 15% (Figure 1d). The B-type natriuretic peptide concentration was elevated at 771.9 ng/L (reference range, $<$18.6 ng/L). PPCM was suspected and an emergent

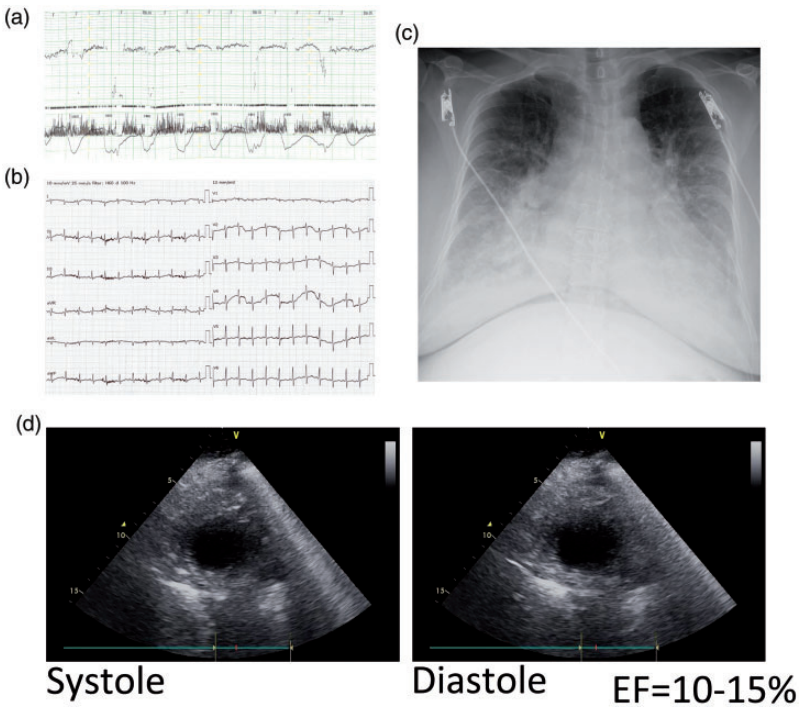

Figure 1. Preoperative examinations. Cardiotocography shows moderate baseline variability (5–10 beats/minute), tachysystole (uterine contractions: 1–1.5 minutes apart), and severe variable decelerations (a). Electrocardiogram showing tachycardia at 150 beats/minute (b). Chest X-ray shows pulmonary edema (c). Echocardiography showing diffuse hypokinesis with a reduced ejection fraction (EF) of 10% to 15% (d).

cesarean section for maternal indication was planned. The time course data of other preoperative blood examination variables from baseline are shown in Supplementary Table 1.

We planned to slowly induce general anesthesia using midazolam and fentanyl with percutaneous cardiopulmonary support (PCPS) on standby. This decision was made for the following reasons. 1) Management with spinal or epidural anesthesia was not possible because of the requirement for mechanical ventilation. 2) Maintaining hemodynamics after anesthesia induction can be challenging. The patient was admitted to the operation room in the sitting position with bilevel positive airway pressure support. She had two peripheral intravenous lines and an arterial blood pressure catheter. The patient was asked to lie down on the operation bed for anesthesia induction, but she panicked and resisted because of labor pain and severe dyspnea. In the struggle, one of the peripheral intravenous line catheters and the arterial blood pressure catheter were dislodged. We intended to administer anesthetics for general anesthesia after introducing sheaths for PCPS by the femoral approach. However, we had no choice but to begin anesthesia induction without any support. Supplementary Figure 1 shows the anesthesia record. We administered 30 mg of propofol to sedate the patient and she successfully achieved light sedation. Subsequently, a continuous infusion of remifentanil at 0.1 μg/kg/minute was initiated. She was also administered 2 mg of

midazolam, 250 µg of fentanyl, and 50 mg of rocuronium, followed by intubation. Phenylephrine was used as required to maintain her hemodynamics. Sheaths for PCPS were then inserted by the femoral approach after anesthesia induction. When the fetal heart rate reached approximately 90 bpm, we initiated the operation by inserting a central venous catheter through the right jugular vein. The neonate (boy, 2602 g) was delivered within 2 minutes. Apgar scores were 0 and 4 at 1 and 5 minutes post-delivery, respectively. The neonate was immediately intubated and resuscitated by a trained neonatologist. Finally, the operation was completed without any failure of hemodynamics, under the support of dopamine and noradrenaline (Supplementary Figure 1).

After the cesarean section, the patient was transferred to the intensive care unit and was provided mechanical ventilation. Figure 2 shows the postoperative course of the patient. Noradrenalin was continued and dobutamine was initiated. Treatment was provided with furosemide and carperitide (human atrial natriuretic polypeptide) for elevated B-type natriuretic peptide concentrations and pulmonary edema as shown on a postoperative X-ray image. On postoperative day (POD) 5, the patient showed improvement in respiratory function and was extubated. Although echocardiography did not show adequate improvement in cardiac function, her hemodynamics gradually stabilized. The patient was moved from the intensive care unit to the ward on POD 7. Additionally, guideline-recommended optimal medical therapy for heart failure was initiated with 1.25 mg/day enalapril and 25 mg/day spironolactone on POD 7, and 2.5 mg carvedilol two times a day on POD 9. A myocardial biopsy performed on POD 23 did not result in a definitive diagnosis. The patient was discharged from the hospital on POD 34. The dose of medications

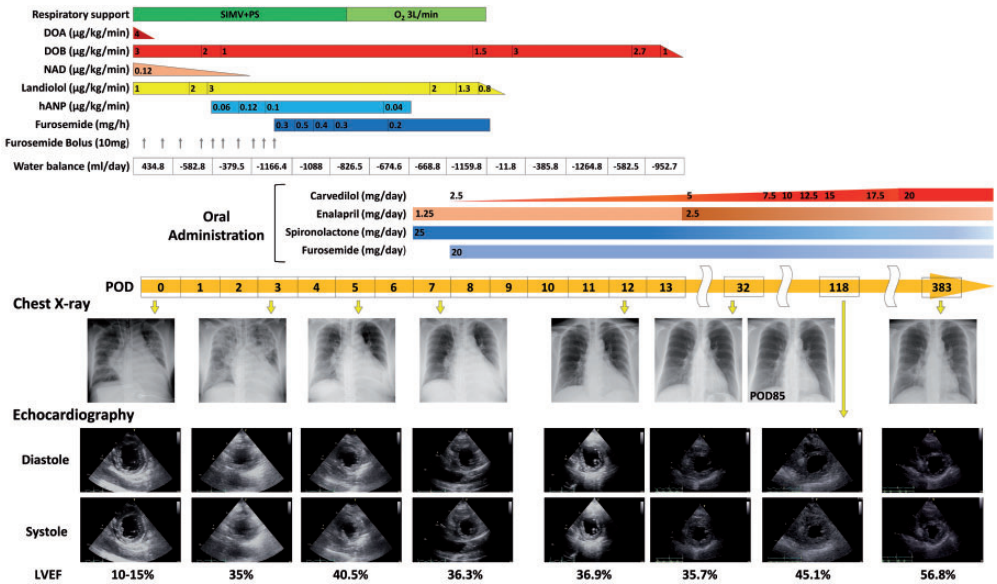

Figure 2. Postoperative course. The patient's cardiac function gradually improved.
SIMV, synchronized intermittent mandatory ventilation; PS, pressure support; DOA, dopamine; DOB, dobutamine; NAD, noradrenaline; hANP, human atrial natriuretic polypeptide; POD, postoperative day; LVEF, left ventricular ejection fraction.

was gradually titrated in our outpatient clinic, and her LVEF values gradually improved to 35.7%, 45.1%, and 56.8% on PODs 32, 118, and 383, respectively.

Discussion

The reported incidence rate of PPCM ranges from 1/102 in Nigeria to 1/20,000 in Japan.[3,4] In the United States, the incidence of PPCM increased from 1/1181 in 2004 to 1/849 in 2011, in association with advanced maternal age.[5] In our patient, we could not exclude the possibility of doxorubicin-induced cardiomyopathy due to R-CHOP therapy. However, the cumulative administered doxorubicin dose in our patient was 300 mg/m^2, whereas the reported incidence of cardiomyopathy after a 400-mg/m^2 cumulative doxorubicin dose ranges from 3% to 5%.[6] Therefore, our patient was diagnosed with PPCM in accordance with the diagnostic criteria.

The anesthetic management of patients with heart failure undergoing cesarean section is challenging, and whether general or regional anesthesia is appropriate remains unclear.[7] Because regional anesthesia has been safely performed in some cases of PPCM,[8–11] regional anesthesia is not always contraindicated. However, the reported cases managed by regional anesthesia had relatively stable respiratory and cardiac function, and some of the reported PPCM cases developed cardiac arrest after anesthesia induction.[12,13] Therefore, only general anesthesia is indicated for patients with severe cardiac and respiratory failure. In the present emergent case, we had to urgently decide whether the mother or the fetus should be prioritized. The presence of a trained neonatologist at the time of delivery was an important factor in reaching the decision of prioritizing the mother's safety in the present case.

The most important concern during general anesthesia induction in cases with severe cardiac dysfunction is the maintenance of hemodynamics. Any anesthetic agent can lead to a decrease in afterload, potentially resulting in hemodynamic collapse. Therefore, midazolam and fentanyl are commonly preferred in patients with cardiac dysfunction because of the relatively slow onset of the anesthetic effect and low effect on hemodynamics, respectively. These effects provide sufficient time to respond to the hemodynamic changes by an anesthesiologist. In particular, fentanyl is widely used to stabilize hemodynamics, and is known as "high-dose fentanyl anesthesia" or "moderate-dose fentanyl anesthesia". However, in the present case, we had to use propofol instead of the initial plan because the patient panicked and resisted on the operation bed. Propofol is widely used for general anesthesia for cesarean section because of its rapid onset and lack of effect on blood flow of the placenta.[14] However, propofol may induce hemodynamic collapse because of a decrease in afterload in patients with cardiac failure. However, the present challenging case was successfully managed. Subsequently, approximately 4.5 μg/kg fentanyl and 0.1 μg/kg/minute remifentanil were administered by the time of intubation to obtain deeper anesthesia. This anesthesia was required because the stress of tracheal intubation under inadequate sedation can potentially lead to ventricular fibrillation or cardiac arrest in these cases. However, because opioid use in cesarean section might cause neonatal respiratory depression, it should be avoided when possible. As a result, in the present case, the neonate required intubation and resuscitation, but fully recovered. Because data from the primary facility showed no abnormalities in the estimated fetal body weight, amniotic fluid volume, or umbilical cord blood flow, we consider that fetal distress was caused by the anesthetic agents and hypoxia. No abnormalities were observed in his

growth or development at the time of discharge and at a 1-year medical checkup. All of the agents that we chose at this time were used for maintaining maternal hemodynamics. However, the dose of fentanyl and remifentanil would have been too high for the neonate. To save the mother and fetus, appropriate selection of possible agents and the dose should be considered. Even a 0.5- to 1.0-μg/kg fentanyl bolus significantly decreases the Apgar score at 5 minutes post-delivery, whereas 2- to 3-μg/kg/hour remifentanil infusion does not significantly affect the Apgar scores at 1 and 5 minutes post-delivery.[15] Therefore, low-dose remifentanil could be used safely in the present case. However, whether low-dose remifentanil is adequate to eliminate the stress of tracheal intubation remains unclear. Ketamine may be the best agent for such cases. A meta-analysis regarding hypnotic agents for general anesthesia of cesarean section reported that ketamine might result in a lower Apgar score.[16] However, some studies showed that ketamine caused higher systolic blood pressure compared with thiopental,[17] and up to 1.0 to 1.5 mg/kg of ketamine did not affect the Apgar score.[18,19] The use of phenylephrine in our patient to maintain maternal hemodynamics might also have led to neonatal asphyxia by worsening the uterine blood flow.

Mechanical circulatory support may provide an effective and relatively safe approach for the mother and the fetus. Approximately 78% to 89% of mothers and 65% to 78% of fetuses survive treatment with extracorporeal membrane oxygenation (ECMO).[20–22] However, the use of extracorporeal life support approaches, such as ECMO and PCPS, from the start of the cesarean section remains controversial. There have been a few published reports of extracorporeal life support use in pregnant women with PPCM.[23–26] Only one of the reported patients underwent cesarean section with PCPS support,[26] whereas the remaining patients were treated after delivery. Bouabdallaoui et al. reported 10 consecutive patients with PPCM who received veno-arterial-ECMO.[27] These cases, albeit critically important, were treated after delivery or in the postpartum period. Some patients were reported to have undergone successful delivery while on ECMO, whereas approximately 33% of the patients were reported to develop bleeding complications.[22] Mikami et al. reported the risk of uncontrollable bleeding in patients with PPCM on ECMO during delivery because of anticoagulant therapy.[26] The authors recommended consideration of immediate hysterectomy in these patients. The operation should be finished without using PCPS, but if necessary, PCPS should be used after the delivery rather than before. We planned to insert the sheaths for PCPS before surgery because the presence of these sheaths before surgery enables establishment of PCPS as quickly as possible after delivery. However, shortening the duration of the supine position before delivery would be best and unnecessary stress should be avoided. Which risk should be taken or avoided may be different in each case depending on the situation, such as the patient's condition and the presence of appropriate facilities and specialists.

In patients with severe orthopnea, inducing anesthesia in the supine position is impossible, but initiating anesthesia in the sitting position may be easier and safer. Kim et al. reported a similar patient with PPCM to our patient in whom anesthesia was induced in the sitting position because of severe dyspnea.[23] To avoid the patient's panic and struggling due to severe dyspnea, anesthesia may need to be started with light sedation with midazolam while remaining in the sitting position, and then they should be laid down.

Although the recovery of cardiac function differs among studies, reports have shown that nearly 62% patients with

PPCM improve, whereas 25% do not respond to treatment and 10% eventually require transplantation.[28] McNamara et al. (Investigations of Pregnancy-Associated Cardiomyopathy study investigators) reported that the LVEF and LV end-diastolic diameter at presentation may be good predictors for myocardial recovery.[29] They found that 91% of patients had an LVEF of >30% plus an LV end-diastolic diameter of <6.0 cm, 62% of them had either of these parameters at presentation, and 0% of them had neither of these parameters at presentation and recovered to a final LVEF of >50% 12 months later.[29] The LVEF at presentation was 10% to 15% in our patient, who showed cardiac recovery based on an LVEF of >50% at a 1-year follow-up visit. This difference between studies may be associated with differences in race. The Investigations of Pregnancy-Associated Cardiomyopathy study investigators have recently suggested that global LV strain is closely associated with the recovery of LV function and may be a potential predictor of prognosis in patients with PPCM.[30] Global longitudinal strain and global circumferential strain speckle-tracking echocardiography have been used to assess LV strain in these patients.[30]

Regarding treatment in the chronic phase, optimal medical therapy is essential to improve the prognosis of patients with PPCM, heart failure, and a reduced LVEF. Angiotensin-converting enzyme inhibitors, beta-blockers, and aldosterone antagonists should be considered for patients with heart failure because of the mortality benefit afforded by these agents. In addition to traditional drugs, the angiotensin-2 receptor blocker/neprilysin inhibitor combination and ivabradine have recently become available in daily clinical practice. These new drugs are solid drug candidates for the treatment of heart failure with a reduced LVEF.[31–33]

Conclusion

Currently, there are no alternatives to general anesthesia for patients with PPCM presenting with orthopnea requiring a cesarean section. Because anesthesia induction in the usual supine position is impossible in these patients, anesthesia should be started with light sedation while remaining in the sitting position. Fentanyl should be avoided, but ketamine or low-dose remifentanil may be a feasible option to maintain maternal hemodynamics and prevent neonatal asphyxia.

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Author contributions

YK performed anesthesia and wrote the manuscript. TN supervised the anesthesia and completed the manuscript. JA performed postoperative management and edited the manuscript. HN and TH performed postoperative management. TY and TM performed the surgery. OY, TS, and TY edited manuscript. All authors have read and approved the manuscript.

Availability of data and material

Datasets supporting the conclusions of this article are included in the article.

Ethics statement

Approval for the study protocol was not necessary because our institutional review board does not require approval for case reports. We obtained written informed consent from the patient regarding the publication of this case report and the use of related data. We obtained informed consent for treatment from the patient.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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