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Peripartum cardiomyopathy with severe mitral regurgitation: A novel application of an intra-aortic balloon pump as a bridge to recovery

Elisa Padron, BSA*; Anne R. Waldrop, MD; Kathleen Minor, MD; Abha Khandelwal, MD; Jess Ansari, MD; Deidre J. Lyell, MD; Katherine Bianco, MD

***Corresponding Author: Elisa Padron**
Stanford University School of Medicine, USA.
Email: ep23874@stanford.edu

Abstract

Intra-aortic balloon pumps may be used in hemodynamically unstable patients to reduce afterload, improve coronary perfusion, and prevent myocardial damage. Peripartum cardiomyopathy is a state of hemodynamic compromise, however, mainstays of treatment include optimization of preload and inotropic support through medical management. Data for use of intra-aortic balloon pumps in peripartum cardiomyopathy are limited to case reports in situations that are refractory to medical management. We present a case of a 29-year-old primigravida with dichorionic-diamniotic twin gestation at 32 weeks 2 days gestation and a history of lupus, who presented with threatened preterm labor and dyspnea. Chest x-ray revealed pulmonary edema and mild cardiomegaly. Echocardiogram initially showed a normal ejection fraction with moderate to severe eccentric mitral regurgitation and an elevated right atrial pressure of 20 mmHg. Over the next 24 hours her ejection fraction decreased from 62% to 50.4%. A multidisciplinary team compromised of Cardiology, Anesthesiology, Maternal Fetal Medicine and Intensive Care specialists recommended delivery via Cesarean birth. Given the anticipated hemodynamic changes with delivery, the Cardiology team recommended she receive an intra-aortic balloon prior to delivery. She underwent a scheduled intra-aortic balloon pump placement followed by Cesarean birth under neuraxial anesthesia with mild anxiolysis. Both procedures were uncomplicated. The intra-aortic balloon pump was removed the day of surgery and she was managed with losartan, furosemide, and metoprolol. She was discharged on metoprolol and her ejection fraction increased to 56% by 2 months postpartum. Intra-aortic balloon pump can be considered for additional hemodynamic support during delivery in the setting of progressive peripartum cardiomyopathy.

Keywords

Peripartum cardiomyopathy; Cardiomyopathy; Intra-aortic balloon pump; Twin gestation; Mitral regurgitation; IABP.

Abbreviation

LVEF: ejection fraction; IABP: intra-aortic balloon counter pulsation; PPCM: peripartum cardiomyopathy; ECMO: Extracorporeal membrane oxygenation; LVAD: Left ventricular assist device

Introduction

Peripartum Cardiomyopathy (PPCM) affects 1 in 1000 pregnancies worldwide and accounts for 25% to 30% of maternal deaths [1]. The incidence of PPCM is increasing in the US, which may be due to increasing prevalence of known risk factors or improved diagnostic modalities leading to enhanced ascertainment [2]. PPCM is defined as heart failure occurring one month prior to delivery or within 5 months postpartum with no preceding source or heart disease. Echocardiography criteria to define PPCM include a left ventricular ejection fraction (LVEF) of less than 45%, left ventricular end diastolic dimension >2.7 cm/m^2 or motion-mode fractional shortening <30% [3,4]. Experts theorize that PPCM stems from a two-hit phenomenon, in which patients with one or more predisposing genetic variants (first hit) sustain a secondary insult from pregnancy [4]. The pregnancy related insult is traced to hormonal, biochemical and hemodynamic adaptations. The maternal pituitary secretes prolactin, which is cleaved into vasoinhibin and mediates direct myocardial damage. In turn, the placenta secretes soluble Fms-like tyrosine kinase-1, which inhibits vascular endothelial growth factors that are required for vascular health [4]. The increased placental mass in multifetal gestations may explain, in part, the increased risk for PPCM within this population [4]. In addition to multifetal gestations, clinical risk factors for PPCM include age greater than 30, black race, hypertensive disorders of pregnancy, and a history of PPCM [3,4,5-9].

Peripartum represents a period of significant risk for hemodynamic compromise amongst patients with PPCM. During labor, delivery, and immediately postpartum, cardiac output is increased by 60% to 80%. Cardiac output and circulating blood volume is 15% greater in twin compared to singleton gestation, further exacerbating hemodynamic compromise [10]. The physiologic changes of pregnancy put patients with PPCM at risk for pulmonary edema and arrhythmia [10].

Current medical treatment for PPCM includes: diuresis to manage pulmonary edema by reducing preload, antihypertensives to diminish afterload in hypertensive patients, inotropes to protect the myocardium, and oxygen therapy for hypoxic patients [4,11]. Morbidity can be reduced through the use of anticoagulation to prevent thromboembolic disease and consideration of telemetry to monitor for malignant arrythmias [4]. If medical therapy fails to improve hemodynamic status, mechanical circulatory support can be used. Circulatory support devices include intra-aortic balloon counter pulsation (IABP), extracorporeal membrane oxygenation (ECMO), and left ventricular assist device (LVAD). These devices can be utilized while the patient is recovering from heart failure, in transition to a durable device, or in severe circumstances, a bridge to transplant [11].

The use of IABP in cardiogenic shock patients can serve to increase LVEF [12]. There is evidence for use of IABP in the gravid population among those with myocardial infarction, postpartum hemorrhage and preexisting dilated cardiomyopathy, however, there are few reports of IABP use in PPCM [13-15]. To place

an IABP, vascular access is normally gained via the femoral artery and the balloon is deployed in the thoracic aorta. Throughout the cardiac cycle, the balloon inflates during diastole and deflates during systole, thus providing coronary perfusion and reducing after load [16]. IABPs are not without risks, which include limb ischemia, access site hemorrhage, severe bleeding or failure of the device. Another consideration is the need for femoral access for IABP placement may affect the patient's ability for hip flexion during vaginal birth. Thus, we report a case of a patient with PPCM and a twin gestation who underwent Cesarean birth with successful preoperative IABP placement and post operative IABP removal. This case will demonstrate the use of IABP in properly selected obstetric patients.

Case Report

A 29-year-old primigravida with a dichorionic-diamniotic twin pregnancy presented with preterm contractions at 32 weeks 2 days gestation. She received two doses of oral nifedipine for tocolysis and antenatal steroids at presentation. Contractions initially worsened, then arrested at 0.5 cm cervical dilation on the day of admission. She had a history of systemic lupus erythematosus, managed with hydroxychloroquine and no prior cardiac history. On admission day 2, the patient complained of progressive dyspnea. Her oxygen saturation decreased to 94% on room air, and she required 5 liters of oxygen. Evaluation revealed no evidence of an infectious etiology. A chest x-ray showed moderate to severe pulmonary edema and cardiomegaly (Figure 1) and an EKG illustrated sinus tachycardia. Initially, an echocardiogram demonstrated moderate to severe eccentric mitral regurgitation, a right atrial pressure of 20 mmHg and a LVEF of 62% (Figure 2). There was no evidence of mitral valve prolapse and the biventricular sizes were preserved. Fetal status remained reassuring. Rheumatologic evaluation suggested that lupus flare or Libman-Sacks endocarditis were low on the differential diagnosis. Progressive symptoms triggered a repeat echocardiogram 24 hours after the initial exam and revealed severe mitral regurgitation with a LVEF of 50.4% (Figure 2). Pro-NT-BNP levels had risen from 39 pg/mL to 3013 pg/mL. At this time, a presumptive diagnosis of PPCM was made and she was started on furosemide.

A multidisciplinary team arranged for the patient's transfer to the Intensive Cardiovascular Care Unit. Due to the patient's cardiopulmonary compromise, delivery by Cesarean was planned at 33 weeks and 1 day in an operating room adjacent to the cardiovascular unit rather than on the maternal ward. Due to PPCM with severe mitral regurgitation and anticipated hemodynamic shifts during delivery, a prophylactic intra-aortic balloon pump (IABP) was placed prior to Cesarean birth to optimize afterload reduction and to improve forward flow. During the Cesarean birth, an ECMO circuit was available if required.

Prior to the IABP and Cesarean birth, anxiolysis was provided with low dose midazolam and dexmedetomidine. High flow humidified oxygen was up-titrated to 50 liters per minute via nasal cannula to manage dyspnea and allow supine positioning without intubation for the procedure. An arterial line and pulmonary artery catheter were placed, followed by a combined spinal/epidural with slow titration of local anesthetic to prevent rapid sympathectomy. Once anesthesia was adequate, the IABP was placed via a sheath in the patient's femoral artery. An uncomplicated Cesarean birth was performed, and both neonates had normal Apgar scores and birth weights of 1.76 kg. The patient's mean arterial pressure was maintained

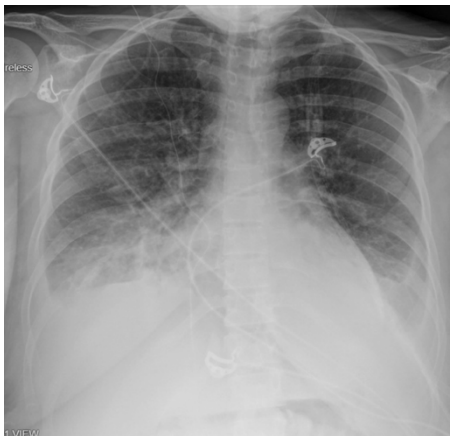

Figure 1: A chest x-ray during third day of admission showing bilateral pleural effusions.

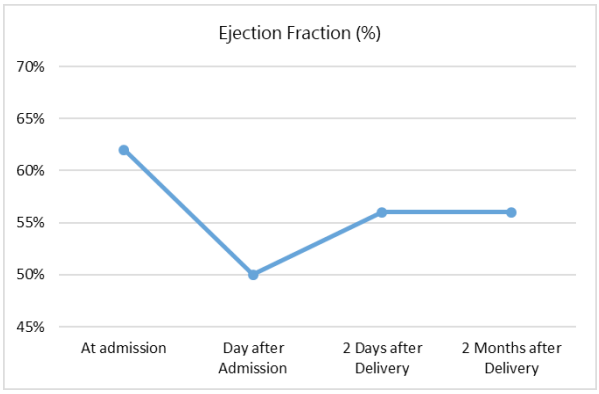

Figure 2: Ejection fraction of patient with mitral regurgitation before and after IABP prophylactically used during Caesarean section.

throughout the procedure (Figure 3).

Following ongoing stability in the CCU for several hours after delivery, the IABP was weaned and subsequently removed. The patient remained in CCU for 24 hours for observation and diuresis, and she was transferred to the postpartum unit. On postpartum day 1, she developed pre-eclampsia without severe features and remained mostly normotensive. She developed pulmonary edema, which was attributed to PPCM. An echocardiogram was repeated following IABP removal showed improved mitral regurgitation and cardiomyopathy with a LVEF of 56% (Figure 2). In the postpartum period, she was managed with losartan, furosemide, and metoprolol. She was discharged on post-operative day 5 on metoprolol succinate 50 mg daily, which she remained on for 1 year. Her cardiac function returned to normal by 2 months postpartum (Figure 2). She underwent genetic evaluation, which was inconclusive for inherited disease due to a variant of unknown significance.

Discussion

In this case, prophylactic IABP allowed for successful delivery of twins in a patient who presented with progressive dyspnea, and acute severe mitral regurgitation, concerning for rapidly progressive PPCM. The case illustrates how effective management by a multidisciplinary team in a tertiary medical center expedited diagnosis and optimization of treatment for a critically decompensating patient. IABP supported myocardial perfusion and forward flow during the delivery and allowed for prompt postpartum recovery of her left ventricular function. Our case is unique given the severity of our patient's cardiovascular dysfunction with rapid recovery postpartum, including a return to an ejection fraction of 56% within 2 months.

A case report by Samalavicius et al. describes preemptive use of an IABP before Cesarean birth. Their patient had a LVEF of 25% prior to IABP. At the time of postpartum discharge, her echocardiogram continued to demonstrate left ventricular dilation and a decreased LVEF of 34%. She remained in heart failure and ultimately required a transplant [17].

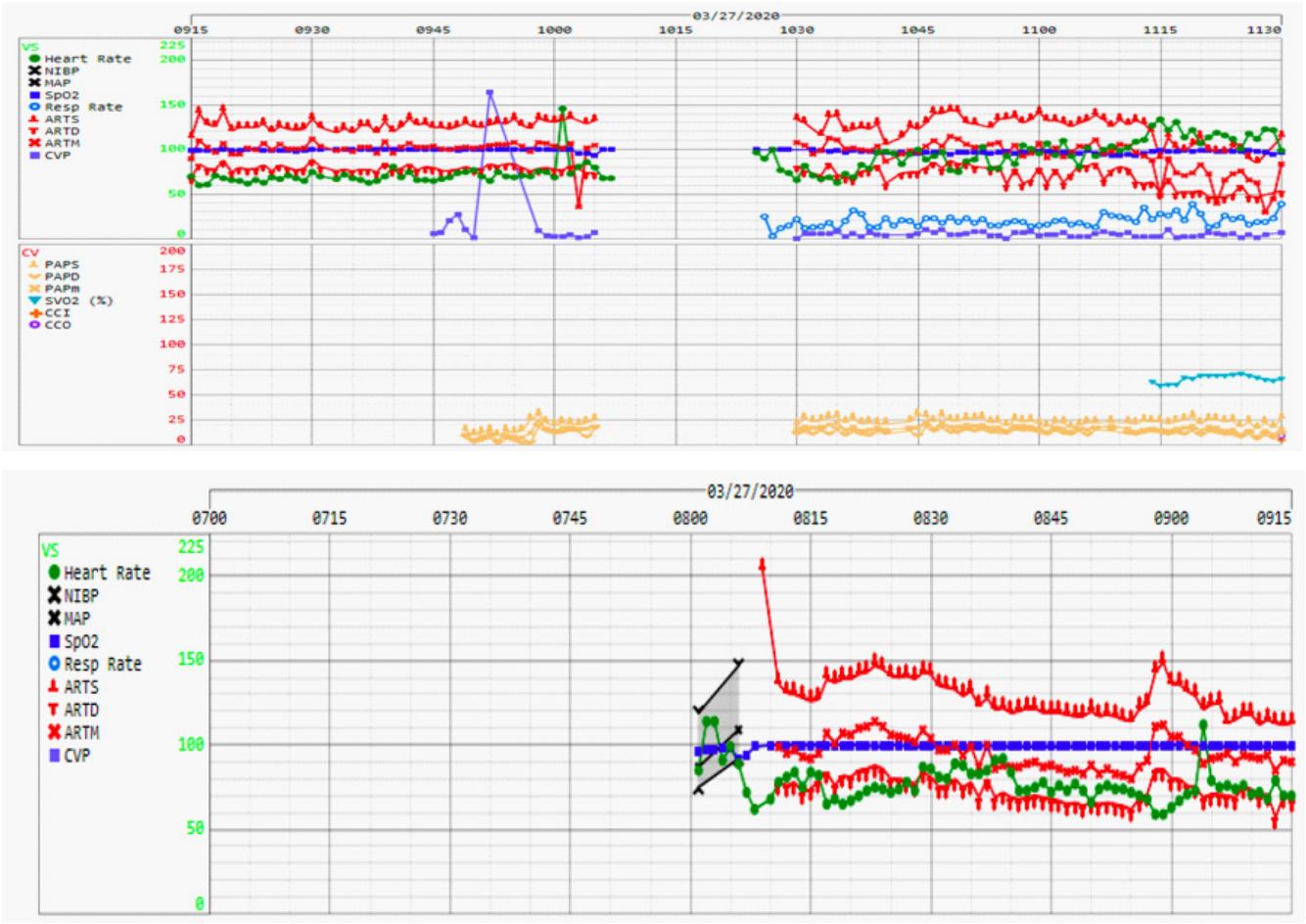

Figure 3: Intraprocedural graph: IABP placed at 9:05 am while in hybrid OR. Fetal deceleration at 1:1 augmentation, repositioned balloon and neonatal status improved. 10:12 am moved patient to operating room for Cesarean. Delivery of baby A at 11:13 and baby B at 11:17 am.

Both our case and Salamavicius's case report show similar patient presentations, use of a multidisciplinary team, and utilization of an IABP during a Cesarean birth. However, our case is distinct in that our patient's cardiac dysfunction was not as severe. Furthermore, it is impossible to discern our patient's trajectory without an IABP, but it is plausible that early intervention of an IABP and delivery decreased further myocardial damage, minimizing her need of a transplant.

One of the largest case series of IABP utilization in severe PPCM includes 6 cases from a single center, over a 10-year period [18]. Gevaert et al. describe three cases with IABP placement during Cesarean birth and three with placement postpartum. Of those with placement prior to delivery, patients presented between 35-38 weeks gestation. One patient was weaned off of IABP and remained in heart failure which was medically managed, one received an LVAD as a bridge to transplantation and one developed refractory cardiogenic shock and required ECMO, followed by LVAD and transplantation. This case series illustrates the high risk for maternal and neonatal complications among this cohort including: stillbirth, bleeding at the anastomosis of the aortic ECMO cannula, rupture and hematoma of the descending aorta with LVAD implantation, spontaneous rectus hematoma on supratherapeutic anticoagulation and occlusion of the right femoral artery [18]. This case series does not state other characteristics to compare our case

report to, except the timeline and follow up of patients. With the early use of IABP in our case, our patient experienced a relatively benign course. The IABP ameliorated the physiologic demands of delivery on her cardiovascular system and was weaned postpartum without complications. The cases described and our case highlight why research is needed to understand the factors affecting recovery time and progression of PPCM in the postpartum period.

Patients with PPCM may not respond to medical management or have time for optimization and titration prior to delivery. In such patients, the prophylactic placement of IABP can serve as a bridge to overcome the anticipated hemodynamic insults of the peripartum period. Our case presents evidence for IABP placement during Cesarean birth to prevent the need for ECMO or a LVAD. In our patient, this resulted in full recovery by 2 months postpartum. Anticipating the projected path of a patient's course may be important to understanding who may benefit from IABP. Future studies are needed to further elucidate the risks and benefits of prophylactic IABP placement in PPCM prior to Cesarean birth. Methods must be employed to risk stratify patients and characterize what phenotypes of cardiogenic shock would most benefit from the intervention to lessen maternal cardiac morbidity and mortality. Based on our experience, delivery in a tertiary hospital where a multidisciplinary team can evaluate and create an individualized delivery plan for patients is of utmost importance.

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Authors Information: Elisa Padron, BSA[1]*; Anne R. Waldrop, MD[2]; Kathleen Minor, MD[2]; Abha Khandelwal, MD[3]; Jess Ansari, MD[4]; Deidre J. Lyell, MD[5]; Katherine Bianco, MD[2]

[1]Stanford University School of Medicine, USA.

[2]Department of Maternal Fetal Medicine and Obstetrics, Department of Obstetrics and Gynecology, Stanford University School of Medicine, Stanford, CA, USA.

[3]Department of Cardiovascular Medicine, Stanford University School of Medicine, USA.

[4]Department of Anesthesiology, Stanford University School of Medicine, USA.

[5]Department of Maternal Fetal Medicine, Perioperative and Pain Medicine, Stanford University School of Medicine, USA.

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