

CASE REPORT

Anesthesia Management of Simultaneous Cesarean Section and Valve Replacement: A Tight-rope Walk Twice!

¹Ruchi A Jain, ²Shakuntala Basantwani, ³Surabhi Nellore, ⁴Bharati A Tendolkar

ABSTRACT

Background: Rheumatic valvular stenosis is the most common valvular heart disease which is encountered in pregnant patients in our country. Combination of severe mitral or aortic stenosis (AS) and physiological changes that accompany pregnancy amplifies problems.

Case report: Two patients with severe rheumatic valve stenosis underwent simultaneous cesarean section (CS) and valve replacement (VR) surgeries. Heart rate (HR) control with diltiazem was required in one patient who was in atrial fibrillation (AF). Anesthesia was induced with etomidate and rocuronium. Cesarean section was performed followed by VR.

Conclusion and clinical significance: Management of anesthesia for such cases is a challenge, as there is a risk of worsening cardiac failure at multiple stages, increasing maternal and fetal morbidity and mortality. The conventional high-dose opioid-based anesthesia strategy followed for VR in stenotic lesions may cause neonatal respiratory depression requiring ventilatory support. A tight balance between maintaining maternal hemodynamics, uterine blood flow, and fetal oxygenation is required for good maternal and fetal outcomes.

Keywords: Anesthesia, Aortic stenosis, Cesarean section, Mitral stenosis, Rheumatic heart disease.

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BACKGROUND

Prevalence of heart disease in pregnancy ranges from 0.3 to 3.5%.¹ As the severity of heart disease increases, the cardiac complication rate increases.² Mitral stenosis (MS) is the most common lesion in rheumatic heart disease (RHD), whereas AS is a relatively rare lesion. Patients with

severe stenotic valve lesions do not tolerate well the physiological changes of pregnancy and the chance of cardiac failure increases from the second trimester onward. Timely termination of pregnancy may help reduce this additional burden on the heart. However, refractory cardiac failure may ensue and emergency CS and VR remain the only choice in such a situation. The anesthetic management of combined surgery in the same sitting has many challenges as this report of two cases reveals.

CASE REPORT

We present a report of two patients who underwent simultaneous CS and VR surgery. The clinical details of both patients are given in Table 1.

Case 1

A 23-year-old primigravida, diagnosed case of severe MS, with valve area of 1.1 cm², severe pulmonary artery hypertension [mean pulmonary artery pressure (PAP) of 52 mm Hg], AF and left atrium (LA) thrombus (28 mm × 28 mm) was admitted in the 32nd week of pregnancy for safe confinement with a plan for elective CS. She was receiving metoprolol, furosemide, digoxin, and warfarin. Warfarin was replaced by unfractionated heparin. Betamethasone was started for fetal lung maturity. However, within 3 days of admission, she developed orthopnea. Physical examination revealed HR of 120 beats/minute irregularly irregular, blood pressure (BP) of 146/96 mm Hg, respiratory rate of 36 to 40/minute, and bilateral crepitation. She was ventilated with continuous positive airway pressure (CPAP) of 10 mm Hg and fraction of inspired oxygen (FiO₂) 0.9. Her oxygen saturation (SpO₂) was 95% and arterial blood gas revealed pH 7.29, partial pressure of oxygen 88 mm Hg, and partial pressure of carbon dioxide 27 mm Hg. Two-dimensional echocardiography (2D-ECHO) revealed persistent AF, worsening of MS (valve area 0.7 cm²), increase in size of clot (47 mm × 28 mm), and pericardial effusion. Despite aggressive medical management, progressive refractory cardiac failure ensued. After discussion with the cardiologists, cardiac surgeons, obstetricians, anesthesiologists, and neonatologists, it was decided to do an emergency CS followed by mitral valve replacement (MVR) in the same sitting.

¹Assistant Professor, ²Associate Professor, ³Consultant
⁴Professor and Head

^{1,2,4}Department of Anesthesia, Lokmanya Tilak Municipal General Hospital and Lokmanya Tilak Municipal Medical College, Mumbai, Maharashtra, India

³Department of Anesthesia, MGM New Bombay Hospital, Navi Mumbai, Maharashtra, India

Corresponding Author: Ruchi A Jain, Assistant Professor Department of Anesthesia, Lokmanya Tilak Municipal General Hospital and Lokmanya Tilak Municipal Medical College Mumbai, Maharashtra, India, e-mail: ruchiajain@gmail.com

Table 1: Clinical information of both patients

Parameter	Case 1	Case 2
Age	23 years	25 years
Parity	Primigravida	Second gravida
Diagnosis	Rheumatic heart disease	Rheumatic heart disease
Weeks of gestation	32	38
History	DOE grade II progressed to grade IV, palpitations	DOE grade III
Examination findings	HR: 120–140/min irregularly irregular BP: 146/96 mm Hg RR: 35–40/min Bilateral crepitation	HR: 70/min regular BP: 110/70 mm Hg RR: 20/min
Two-dimensional echo findings	AF, MVA 0.7 cm ² , calcified mitral valve leaflets, left atrial clot, mean PAP 52 mm Hg, LVEF 50%, pericardial effusion, mild TR	Severe aortic stenosis and thickening with PG 76 mm Hg and MG 45 mm Hg. LVEF 60%, MVA 1.6 cm ² . Mean PAP 35 mm Hg. Mild TR, mild AR
Preoperative investigations	Hb 9.1 gm%, platelet count 173,000/dL, creatinine 0.8 mg/dL, aPTT >2 times control	Hb 10.2 gm%, platelet count 137,000/dL, creatinine 0.7 mg%, INR 1.0
Obstetric ultrasonography	Intrauterine growth retardation	Intrauterine growth retardation
Medications (Reason for change of plan)	Metoprolol, furosemide, digoxin, warfarin	Atenolol, furosemide
Planned mode of delivery	Admission for safe confinement followed by elective LSCS after fetal maturity	Admission for safe confinement followed by elective LSCS after fetal maturity
Reason or change of plan	Cardiac failure	Worsening of pressure gradients across aortic valve

DOE: Dyspnea on exertion; RR: Respiratory rate; MVA: Mitral valve area; LVEF: Left ventricular ejection fraction; TR: Tricuspid regurgitation; PG: Peak gradient; MG: Mean gradient; AR: Aortic regurgitation; Hb: Hemoglobin; aPTT: Activated partial thromboplastin time; INR: International normalized ratio; LSCS: Lower segment cesarean section

Case 2

A 25-year-old second gravida with history of balloon mitral valvotomy for MS and CS in previous pregnancy was admitted for elective CS in view of heart disease. The 2D-ECHO revealed severe AS with peak and mean gradient of 79 and 45 mm Hg respectively. After multi-disciplinary discussion, it was decided to do elective CS and aortic valve replacement (AVR) simultaneously.

Clinical Management

After written informed consent, both patients were prepared for surgery. Monitoring included 5-lead electrocardiogram, pulse oximetry, noninvasive BP, Entropy[®], urine output, and fetal heart rate (FHR). The first patient was transferred to the cardiac operation theater in propped up position with CPAP. She was extremely anxious with HR of 150 to 160 beats/minute. Diltiazem 12.5 mg was given titrated to reduce the HR to around 100/min. Midazolam 0.5 mg and fentanyl 50 µg were given for anxiolysis. Due to orthopnea, right internal jugular vein was cannulated in propped up position and femoral arterial line was taken under local anesthesia. In the second patient, invasive lines were secured in supine position. The FHR remained between 120 and 130 beats/minute. The operating table was given a left tilt to prevent inferior vena cava compression. Further management was similar in both patients. Etomidate 0.3 mg/kg and rocuronium 1.2 mg/kg were administered intravenously for rapid sequence intubation. Both patients were ventilated with 100% oxygen, maintaining normocarbia till the baby was delivered, which took 7 and 13 minutes respectively.

The Apgar score of the first baby was 3 and 6 at 1 and 5 minutes respectively. The baby was intubated and ventilated. The baby could be extubated after 15 minutes due to clinical improvement. The Apgar score of the second baby was 3 and 5 at 1 and 5 minutes. The baby was intubated and required ventilator support for 6 hours.

After baby delivery, both patients were ventilated using air: oxygen maintaining FiO₂ 0.7. Midazolam 1 mg and fentanyl 150 µg were given. Anesthesia was maintained with fentanyl 5 to 10 µg/kg/hour and vecuronium 0.08 µg/kg/minute maintaining Entropy[®] between 40 and 60. Slow oxytocin infusion was started. Furosemide 20 mg was administered. Abdomen was closed after thorough hemostasis. Fentanyl 100 µg was repeated prior to sternotomy. After instituting cardiopulmonary bypass (CPB), MVR was performed in the first patient and AVR in the second patient was performed using a bio prosthetic valve, maintaining a perfusion pressure of 50 to 60 mm Hg. The details of CPB are mentioned in Table 2. Both patients were weaned

Table 2: Parameters during cardiopulmonary bypass

Operative course	Case 1	Case 2
Total CPB time	1 hour 20 min	2 hours 25 min
Aortic clamp time	55 min	1 hour 45 min
Furosemide	30 mg	20 mg
Ultrafiltrate	600 mL	1000 mL
Urine output	500 mL	750 mL
Total intravenous fluid	500 mL 6% HES 250 mL saline 1 unit PRC	500 mL 6% HES 500 mL RL 1 unit PRC

HES: hydroxyethyl starch, RL: Ringer lactate, PRC: packed red cells

Table 3: Hemodynamic parameters

	Preoperative	Postinduction	1 min after delivery	3 min after delivery	5 min after delivery	10 min after delivery	Post-CPB
Case 1							
HR (beats/min)	150	110	98	110	100	95	98
MAP (mm Hg)	110	100	90	80	78	70	70
CVP (cm of H ₂ O)	14	14	14	18	20	18	12
SpO ₂ %	95	98	98	95	93	97	99
ECG	AF	AF	AF	AF	AF	AF	NSR
Case 2							
HR (beats/min)	80	92	88	78	70	74	90
MAP (mm Hg)	100	96	88	86	80	90	80
CVP (cm of H ₂ O)	8	9	9	10	12	10	9
SpO ₂ %	99	99	99	99	99	99	99
ECG	NSR	NSR	NSR	NSR	NSR	NSR	NSR

MAP: Mean arterial pressure; CVP: Central venous pressure; SpO₂: Oxygen saturation; ECG: Electrocardiograph; NSR: Normal sinus rhythm; AF: Atrial fibrillation

off CPB. Both the patients required dopamine 3 µg/kg/minute for weaning and adrenaline 0.06 µg/kg/min was required in the first case. Hemodynamic parameters of the patients, before and after CS and VR, are shown in Table 3. Furosemide 60 mg and torsemide 20 mg were administered postweaning from CPB to the first patient. The post-CPB hemoglobin of both patients was 7 gm/dL; hence, both received one unit of packed red cells each. The patients were electively ventilated and extubated 14 and 16 hours later respectively. No unusual bleeding was encountered in the perioperative period. Inotropes were gradually tapered and stopped. The first patient was started on warfarin, torsemide, metoprolol, diltiazem, and aspirin. The 2D-ECHO on postoperative day 12 showed persistence of AF and reduction of mean PAP to 38 mm Hg. The patient was discharged on day 22. The second patient was started on aspirin, warfarin, torsemide, and amiodarone, as she developed AF postsurgery. Postoperative 2D-ECHO revealed reduction in peak and mean pressure gradients across aortic valve to 24 and 14 mm Hg and mean PAP of 36 mm Hg. She was discharged on day 20.

DISCUSSION

Rheumatic heart disease is the main cause of heart disease in Indian pregnant patients (88%).³ Our patients were classified as stage D valvular heart disease (severe symptomatic MS and severe symptomatic AS respectively) as per the 2014 American Heart Association/American College of Cardiology (AHA/ACC) guidelines for management of patients with valvular heart disease⁴ and were at extremely high risk (class IV) of maternal mortality or morbidity.⁵ Pregnant patients with severe valve stenosis should be monitored in a tertiary care center with a dedicated team of cardiologists, surgeons, anesthesiologists, and obstetricians with expertise in the management of high-risk cardiac patients during pregnancy.⁵ Mitral valve

surgery may be considered for patients with severe MS (mitral valve area <1.5 cm², stages C and D) who have had recurrent embolic events while receiving adequate anticoagulation.⁴ The AVR is recommended in patients of severe AS with symptoms of heart failure, syncope, exertional dyspnea, angina, or syncope on history or on exercise testing and with mean pressure gradient of 40 mm Hg or higher.⁴ The risk of cardiac failure in pregnant patient with heart disease increases from the second trimester onward. Pregnancy is a hypercoagulable state. Despite maintaining prothrombin times 2.0 to 2.5 times the control value, some patients may demonstrate thromboembolic episodes.⁶ In the first patient, steroids had been given for fetal lung maturity cases and in the second, the fetus had reached the period of viability. Hence, it was decided to proceed ahead with CS and MVR/AVR to remove the additional load placed on the heart secondary to the pregnancy.

The following issues have to be considered while planning combined MVR with CS: (1) anesthetic considerations due to severe MS with AF and LA thrombus; (2) increased risk of fetal hypoxia secondary to maternal hypoxia resulting from pulmonary congestion. Neonatal respiratory depression due to transfer of anesthetic drugs across the placenta compounds the problem; (3) worsening of cardiac failure due to autotransfusion from uterus after baby delivery; (4) increased risk of uterine bleeding.

Meticulous control of HR is needed in MS and AS to maintain left ventricular end diastolic volume and, subsequently, cardiac output. Despite digoxin and metoprolol, the first patient's ventricular rate was 110 to 120 beats/minute and anxiety worsened it. Calcium channel blockers are indicated for rate control in pregnancy only when beta-blockers and digoxin are unsuccessful.⁷ Hence, diltiazem was used for rate control. Remifentanyl provides cardiovascular stability with minimal side

effects in neonate.⁸ Low doses of midazolam and fentanyl were given since they have no adverse effect on neonatal outcome and remifentanyl was not available.⁹ High dose of fentanyl was found to cause severe neonatal respiratory depression necessitating mechanical ventilation.¹⁰

Mitral stenosis and AS are low cardiac output states. Most anesthetic agents used for induction result in hypotension which can reduce uteroplacental blood flow. The combined effect of this low cardiac output state and hypotension may adversely affect the neonatal outcome. Other authors have reported the use of thiopentone for induction which causes hypotension and can worsen tachycardia.¹⁰⁻¹² Also, high dose of fentanyl, when used for induction, can lead to severe neonatal respiratory depression.¹⁰ Etomidate, which has no effect on the sympathetic nervous system, was used to avoid hypotension. Etomidate has been safely used for induction in pregnant cardiac patients.¹³ Heparinization needed during CPB increases the risk of uterine bleeding after CS. We did not encounter increased bleeding similar to the findings of other authors.^{10,12}

Inhalational anesthetics and inotropes with beta-2 agonist effect cause uterine relaxation which may aggravate bleeding. Potential uterine relaxation by inhalational anesthetics was avoided by using fentanyl infusion for maintenance of anesthesia with additional dose of midazolam after baby delivery. We chose oxytocin infusion as methylergometrine increases systemic and pulmonary vascular resistance. There was an increase in the central venous pressure and peak airway pressure (from 14 to 24 cm H₂O) and slight fall in SpO₂ after delivery (Table 1) in the first patient. This can be explained by the autotransfusion which occurs due to contraction of the uterus. Additional furosemide was administered to counter this effect.

CONCLUSION

A combination of etomidate with low-dose fentanyl and diltiazem for HR control helps in achieving the tight balance between preservation of maternal hemodynamics and minimizing neonatal respiratory depression in patients undergoing combined CS with MVR.

CLINICAL SIGNIFICANCE

A thorough knowledge of the pathophysiology of both RHD and pregnancy, prudent choice of anesthesia technique, along with close maternal and fetal monitoring and a multidisciplinary approach can lead to a successful outcome.

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