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CASE REPORT

Anesthetic Management in a Neonate Undergoing Percutaneous Balloon Pulmonary Valvuloplasty: A Case Report

Melike Korkmaz Toker,[1] Çiğdem Sezgin[2]

[1]Department of Anesthesiology and Reanimation, Muğla Sıtkı Koçman University Faculty of Medicine, Muğla, Türkiye
[2]Department of Anesthesiology and Reanimation, Muğla Training and Research Hospital, Muğla, Türkiye

ABSTRACT

Critical pulmonary stenosis (CPS) is a life-threatening congenital heart defect in neonates, requiring prompt intervention. Percutaneous balloon pulmonary valvuloplasty (BPV) has emerged as the treatment of choice, but perioperative anesthetic management remains complex. We report the anesthetic management of a 17-day-old, 3020 g neonate with CPS, a secundum atrial septal defect, and a small ventricular septal defect. Anesthesia was induced with midazolam, fentanyl, and rocuronium, and maintained with continuous midazolam and fentanyl infusion. Normocapnia and moderate FiO_2 were ensured. The patient remained hemodynamically stable throughout the procedure, and BPV was successfully performed without complications. The postoperative course was uneventful. This case illustrates the importance of individualized anesthetic strategies in neonates with CPS. A balanced opioid-based approach, combined with careful respiratory and hemodynamic control, contributed to a safe perioperative course. Recent literature emphasizes the growing safety of BPV when accompanied by vigilant anesthetic care.

Keywords: Anesthesia, balloon pulmonary valvuloplasty, congenital heart disease, neonate, pulmonary stenosis

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Introduction

Critical pulmonary stenosis (CPS) is a rare congenital cardiac anomaly characterized by obstruction at the level of the pulmonary valve, leading to increased right ventricular pressure and impaired pulmonary blood flow. In neonates, this condition can present with cyanosis, right heart failure, and poor perfusion, necessitating urgent intervention. The primary goal of treatment is to relieve the obstruction while maintaining hemodynamic stability and oxygenation. Over the past two decades, percutaneous balloon pulmonary valvuloplasty (BPV) has emerged as the preferred first-line treatment for severe and critical pulmonary stenosis in neonates, offering a less invasive alternative to surgical valvotomy with high success and low complication rates.[1,2]

Despite the procedural advancements in interventional cardiology, the anesthetic management of neonates undergoing BPV remains challenging due to the unique characteristics of neonatal physiology. These patients often present with coexisting cardiac anomalies, immature myocardium, limited ability to compensate for hemodynamic changes, and high sensitivity to anesthetic agents.[3] Right ventricular dysfunction, pressure overload, and the need to preserve coronary perfusion during induction and maintenance of anesthesia require careful selection and titration of drugs.

Recent studies emphasize the importance of individualized anesthetic strategies, focusing on maintaining right ventricular preload, avoiding systemic hypotension, and ensuring adequate oxygenation throughout the procedure.[4,5] Furthermore, combining fluoroscopic and echocardiographic guidance has significantly enhanced the safety and precision of BPV procedures in neonates, reducing procedural time and radiation exposure.[4]

In this report, we present the anesthetic management of a 17-day-old neonate with CPS undergoing successful BPV. We aim to contribute to the limited but growing

Address for correspondence: Melike Korkmaz Toker, MD. Muğla Sıtkı Koçman Üniversitesi Tıp Fakültesi, Anesteziyoloji ve Reanimasyon Anabilim Dalı, Muğla, Türkiye

Phone: +90 505 474 70 98 **E-mail:** meltoker@gmail.com

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literature on perioperative strategies in neonatal cardiac interventions and highlight considerations that may help optimize outcomes in such high-risk patients.

Case Report

Written informed consent was obtained from the patient's parents for the publication of the case report. A 17-day-old male neonate, weighing 3020 grams, was referred to our center with a diagnosis of critical pulmonary stenosis. Echocardiographic evaluation demonstrated a peak systolic pressure gradient of 80 mmHg across the pulmonary valve, accompanied by right ventricular dilation, a small ventricular septal defect (VSD), and a secundum atrial septal defect (ASD). Preoperative oxygen saturation was 88–90% on room air, and vital signs remained stable.

The patient was scheduled for percutaneous balloon pulmonary valvuloplasty in the catheterization laboratory. Standard non-invasive monitoring was established, including ECG, pulse oximetry, and noninvasive blood pressure. Anesthesia was induced intravenously with midazolam (0.1 mg/kg), fentanyl (5 mcg/kg), and rocuronium (0.5 mg/kg). The patient was intubated smoothly without hemodynamic compromise.

Mechanical ventilation was adjusted to maintain normocapnia, with an FiO_2 of 60%. Maintenance of anesthesia was achieved via continuous intravenous infusions of midazolam (0.01 mg/kg/min) and fentanyl (0.01 mcg/kg/min). Invasive arterial and central venous monitoring was established through the right femoral artery and vein.

Throughout the procedure, the patient's hemodynamic parameters—including heart rate, blood pressure, and oxygen saturation—remained stable, with no episodes of hypotension, bradycardia, or arrhythmia. Near-infrared spectroscopy (NIRS) monitoring was employed using a single cerebral probe placed on the forehead to assess regional cerebral oxygen saturation. The baseline value was 62%, and no drop exceeding 20% from baseline was observed during the procedure. The maintenance of hemodynamic stability and normocapnic ventilation contributed to the preservation of adequate cerebral perfusion. The BPV was performed successfully without complications, and immediate post-procedural echocardiography revealed a significant reduction in the pulmonary valve gradient to 35 mmHg. The NIRS value reached 67% after BPV. The patient was extubated uneventfully on postoperative day two and continued to recover without adverse events.

Discussion

Critical pulmonary stenosis (CPS) in the neonatal period presents significant management challenges, not only for interventional cardiologists but also for anesthesiologists. Due to the fixed obstruction at the right ventricular outflow tract and potential coexisting anomalies such as atrial or ventricular septal defects, maintaining right heart function is of paramount importance during anesthetic care. In our case, the patient exhibited both ASD and VSD in addition to severe valvular stenosis, necessitating careful perioperative planning.

The anesthetic strategy focused on maintaining right ventricular preload, avoiding increases in pulmonary vascular resistance, and preserving systemic vascular resistance to support coronary perfusion. The use of fentanyl and midazolam—agents known for their cardiovascular stability—proved to be appropriate for this high-risk neonatal population. Similar approaches have been advocated in recent retrospective studies evaluating catheter-based interventions for CPS, where opioid-based regimens minimized hemodynamic fluctuations and myocardial depression.[2]

Moreover, adequate ventilation is essential to avoid hypoxia and hypercapnia, both of which can increase pulmonary vascular resistance and worsen right ventricular performance. We maintained normocapnia and moderate FiO_2 (60%) throughout the procedure. This is consistent with the findings of Tariq et al.,[3] who highlighted the role of ventilatory strategies tailored to prevent right ventricular strain in neonates with congenital heart disease.

The absence of hemodynamic instability during BPV in our patient is particularly noteworthy. Despite the presence of severe valvular obstruction and right heart dilation, stable heart rate, blood pressure, and oxygenation were maintained throughout the intervention. This supports the growing body of evidence that, when conducted in a controlled and multidisciplinary setting, BPV can be performed safely and effectively even in complex neonatal cases.[1,4]

Inhalational agents were deliberately avoided in this case due to their known myocardial depressant effects and potential to cause systemic vasodilation, which can compromise coronary perfusion in neonates with right ventricular outflow obstruction. Sevoflurane and isoflurane, though commonly used in pediatric anesthesia, have been associated with dose-dependent reductions in myocardial contractility and systemic vascular resistance, which may be poorly tolerated in the setting of critical pulmonary stenosis.[6,7]

Furthermore, advances in procedural imaging—particularly the integration of echocardiographic and fluoroscopic guidance—have improved the safety profile of BPV in neonates. These tools not only enhance anatomical visualization but also reduce procedural time

and exposure to radiation.[5] Although not routinely used in all catheter-based neonatal procedures, NIRS offers real-time, non-invasive insight into cerebral oxygenation and may serve as a valuable adjunct to standard monitoring—particularly in the angiography suite, where early detection of perfusion abnormalities can guide timely interventions.

This case contributes to the limited literature from anesthesiology perspectives regarding BPV in early neonatal life, especially in centers where such interventions are infrequently performed. It highlights the importance of multidisciplinary coordination and vigilant intraoperative monitoring to optimize outcomes.

Conclusion

Percutaneous balloon pulmonary valvuloplasty represents a safe and effective intervention for critical pulmonary stenosis in neonates when accompanied by meticulous anesthetic management. This case illustrates that with a carefully selected anesthetic technique prioritizing cardiovascular stability, adequate oxygenation, and normocapnia, such procedures can be carried out without intraoperative complications. Sharing detailed anesthetic approaches in rare neonatal cardiac interventions may contribute to improved perioperative care and better outcomes in this vulnerable population.

Disclosures

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Written informed consent was obtained from the patient's parents for the publication of the case report.

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