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Case Report

Anesthetic Challenges in a Child with Tetralogy of Fallot and Cerebral Abscess Undergoing Neurosurgery: A Case Report

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ABSTRACT

Tetralogy of Fallot (ToF) represent as the most common cyanotic congenital heart disease and poses significant anesthesia challenges, especially during neurosurgical procedures. Patients require maintenance of systemic vascular resistance (SVR) to prevent worsening right-to-left shunting, while neurosurgery need strict control of intracranial pressure (ICP) and cerebral perfusion. Balancing these concommitant priorities demands an individualized, multidisciplinary approach. We report a 7-year-old girl (15 kg) present with uncorrected ToF and increasing ICP due to cerebral abscess requiring emergency craniotomy. Fentanyl, midazolam, low-dose ketamine, and rocuronium was used for anesthesia induction, continued with sevoflurane as maintenance. Ketamine was selected to preserve SVR and prevent hypercyanotic spells, despite concerns of increased ICP. Intraoperative hemodynamics remained stable, and postoperative recovery went with no major event. At six-month follow-up, complete neurological recovery was achieved. Anesthesia management of uncorrected ToF with concurrent neurosurgical pathology demands physiology-driven drug selection, watchful monitoring, and team coordination. This case highlights the importance of balancing SVR, PVR, and ICP, demonstrating that carefully titrated ketamine remains a safe and effective option in uncorrected ToF-neurosurgical scenarios.

Introduction

Tetralogy of Fallot (ToF) present as the most common form of cyanotic congenital heart disease, accounting for approximately 10% of all congenital heart defects in children [1]. It is characterized by four intracardiac pathology of ventricular septal defect, right ventricular outflow tract obstruction, overriding aorta, and right ventricular hypertrophy, leading to a right to left shunt and chronic hypoxemia [1]. In patients with ToF, chronic hypoxemia may result in compensatory secondary polycythemia, which increases blood viscosity and predispose patients to systemic thromboembolic events, including cerebral abscess formation caused by septic emboli that bypass pulmonary filtration [1-2]. One of the main concerns in patients with ToF undergoing anesthesia procedure is hypercyanotic spell, which refer to acute hypoxemic episodes that can be triggered by infundibular spasm or a sudden decrease of systemic vascular resistance (SVR). During anesthesia, this condition should be anticipated, as it may worsen right-to-left shunting lead to rapid decline in oxygen saturation. [1,3].

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In patients with ToF undergoing neurosurgery, anesthesia management considered as a complex one because cardiovascular stability and intracranial pressure need to be controlled at the same time. The anesthesia approach should therefore focus on preserving SVR, prevent increasing pulmonary vascular resistance (PVR), and maintaining cerebral perfusion without further increasing intracranial pressure (ICP). [3]. Ketamine is often considered as drug of choice in patients with uncorrected ToF regarding to its drug properties that helps preserve SVR so it may prevent the risk of hypercyanotic spells. However, because ketamine may increase cerebral blood flow and ICP, careful consideration is required when it is used during neurosurgical procedures. [3-4]. Therapeutic dilemma occurs when patients with concurrent raising ICP, where ketamine is relatively contraindicated due to concerns of worsening ICP, yet remains one of the few agents capable of stabilizing SVR in patient with uncorrected ToF. While agents such as propofol and thiopental may help to reduce ICP, it may also cause hypotension and worsen the right-to-left shunt [5]. Optimizing cerebral perfusion while preventing desaturation, maintaining normocapnia, and minimizing hemodynamic turbulence requires a multidisciplinary and individualized approach.

To our knowledge, the anesthesia use of ketamine in patients with uncorrected ToF undergoing emergency craniotomy has rarely been reported. This case provides further clinical insight and illustrates the importance of individualized perioperative planning when concurrent cardiac and neurosurgical conditions must be stabilized simultaneously. We report a case of a child with uncorrected ToF and cerebral abscess requiring emergency craniotomy, highlighting anesthesia management dilemmas and perioperative strategies in managing simultaneous cardiac and neurological conditions.

Case Report

A 7-year-old girl was admitted with a 6-day history of dizziness. She was15 kg and a height of 110 cm. On physical examination, she appeared central cyanotic along with digital clubbing with mild respiratory distress. Vital signs showed a blood pressure of 104/68 mmHg, heart rate of 101 bpm, and an oxygen saturation of 50% on room air. A grade III/VI systolic murmur was audible at the left lower parasternal border. Neurological assessment revealed right sided hemiparesis with hyperreflexia and an unclear Babinski sign.

Laboratory findings showed hemoglobin 16.2 g/dL, hematocrit 49%, leukocyte count 26,000/µL, platelet count 576,000/µL, serum sodium 128 mmol/L, potassium 5.1 mmol/L, and calcium 0.54 mmol/L. Contrast-enhanced cranial CT showed an irregular hypodense lesion in the left parietal lobe with ring enhancement complicated with 1.2-inch subfalcine herniation, consistent with a cerebral abscess complicated with supratentorial herniation. Echocardiography confirmed uncorrected ToF with significant right-to-left shunting.

After discussion among the anesthesiologist, neurosurgeon, and pediatric cardiologist teams, emergency craniotomy for abscess evacuation was decided to address the significant increasing ICP process that causing clinical manifestation in our patient. Preoperative treatment included intravenous prophylactic of ceftriaxone 650 mg every 12 hours, metronidazole 100 mg every 8 hours, propranolol 10 mg every 8 hours, dexamethasone 2.5 mg every 8 hours, and correction of hyponatremia using D5 ½ NS at rate of 24 mL/h.

Anesthesia induction was performed with fentanyl 30 mcg, midazolam 2 mg, ketamine 8 mg, and rocuronium 8 mg, proceed with anesthesia maintenance with sevoflurane 3 vol. Continuous monitoring included non-invasive blood pressure, ECG, SpO_2, urine output, and end-tidal CO (EtCO2). Isotonic balanced crystalloids were administered at rate of 40 mL/h for fluid maintenance. Intraoperative hemodynamics remained stable, with systolic blood pressure maintained between 95–110 mmHg, heart rate 90–110 bpm, SpO_2 between 70–80%, and no hypercyanotic episodes. For post-operative care, patient was admitted to pediatric ICU, extubated, and maintained stable vital signs (BP 100/62 mmHg, HR 92 bpm, SpO_2 82% on oxygen).

Significant neurological improvement after surgery was observed. No perioperative complications seen. Patient was discharged after 16 days of care with significant improvement in neurological function. She was continued on oral propranolol 5 mg twice daily. At the six-month follow-up, she remained free of neurological disabilities aside from persistent cyanotic episodes related to ToF.

Discussion

ToF is a congenital structural heart disease arising from abnormal formation of the right sided cardiac outflow tract during early embryogenesis. Its four anatomical components which consists of ventricular septal defect, overriding aorta, pulmonary stenosis, and right ventricular hypertrophy, contribute to right-to-left shunting and chronic hypoxemia [1]. In patients with uncorrected ToF, persistent cyanosis may lead to secondary polycythemia and increased blood viscosity. These changes predispose patients to systemic thromboembolic events, including cerebral abscess formation caused by septic emboli that bypass pulmonary filtration [2].

Anesthesia management in patient with uncorrected ToF undergoing neurosurgery poses unique dilemma, requiring balance between cardiovascular stability and neuroprotection during procedure [4,6].

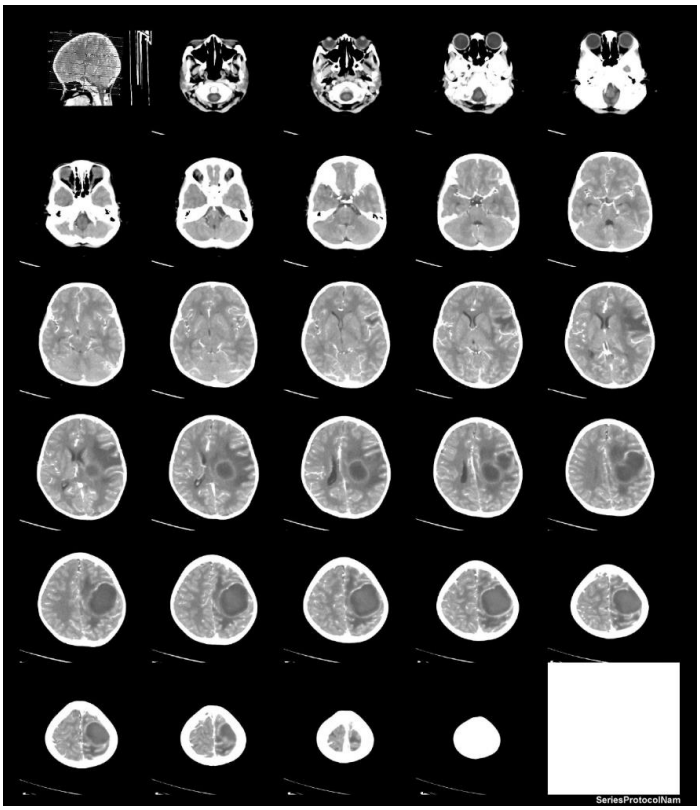

Figure 1- Contrast-enhanced cranial CT scan showing a hypodense lesion in the left parietal lobe with ring enhancement, consistent with a cerebral abscess.

In ToF, the principal goals of cardiovascular anesthesia management during surgery are to maintain SVR, avoid sudden increases in PVR which aim to prevent worsening of right-to-left shunting [4]. While on the other side, neurosurgical anesthesia put maintenance of cerebral perfusion to prevent further increases in ICP, thus avoiding secondary brain injury [7]. These goals may conflict when a patient with uncorrected ToF requiring emergency craniotomy as for in this case.

Regarding to this case, anesthesia was induced with fentanyl, midazolam, low-dose ketamine, and rocuronium. Ketamine was used to preserve SVR and reduce the risk of hypercyanotic spells in uncorrected TOF. Although ketamine has been associated with increased cerebral blood flow and ICP, this effect may be less clinically relevant when ventilation is controlled and cerebral autoregulation is preserved [3,4,8]. For this reason, we used a low, titrated dose ketamine combined with opioid administration to blunt sympathetic stimulation during induction. Previous studies have reported that ketamine's effects on ICP are less pronounced in patients with intact autoregulation and controlled ventilation, suggesting that cautious, titrated use may remain safe in select neurosurgical cases [4].

We highlight the novelty of our approach. We choose to use ketamine despite its relative contraindication; we succeed to balance competing demands of SVR support and ICP control. To minimize the increase of ICP side effect, low titration of ketamine is combined with opioids to minimize sympathetic surges. Controlled ventilation with a target $PaCO_2$ of 35–40 mmHg, preventing hypercapnia-induced cerebral vasodilation and further ICP elevation [3,9]. Alternative induction agents such as propofol and thiopental are avoided due to their potential to lower SVR and worsen the right-to-left shunting. While at the same time we acknowledge etomidate, which offers stable hemodynamics without affecting ICP, would have been an excellent choice, it is unavailable in our setting [8,10]. Anesthesia maintenance is achieved with low-concentration sevoflurane (3%) supplemented by dexmedetomidine infusion. Dexmedetomidine is selected for its ability to provide sedation, minimize sympathetic activation, and offer potential neuroprotective benefits while maintaining stable hemodynamics [4,8,10]. This approach was succeeded to minimize fluctuation in both SVR and ICP, ensuring adequate cerebral perfusion without exacerbating right-to-left shunting in our patient [4,8]. Mechanical ventilation settings are designed to optimize both cardiac and cerebral physiology, maintaining normocapnia to avoid increases in PVR while preventing cerebral ischemia from excessive hypocapnia [8]. Oxygenation is

carefully titrated to provide sufficient FiO_2 to improve systemic oxygen delivery while avoiding hyperoxia-induced cerebral vasodilation [9]. Intraoperative monitoring plays a crucial role in anticipating complications and guiding time-to-time management [9]. Preparation for potential intraoperative crises, such as cyanotic spells, is also prepared. Hypercyanotic spells, characterized by sudden hypoxemia and worsening right-to-left shunting due to infundibular spasm, are life-threatening if not managed promptly [1,4,6]. Prevention includes continuing preoperative beta-blocker with propranolol, minimizing sympathetic stimulation during induction and intubation, and maintaining adequate intravascular volume [4,6]. Rescue strategies, including 100% oxygen, morphine, fluid boluses, and phenylephrine to augment SVR, are prepared alongside esmolol to avoid refractory infundibular spasm [4,8]. Similar perioperative strategies have been emphasized in previous reports on ToF anesthesia management, but emergency neurosurgical procedure indication in our case underscores the complexity of balancing these measures when ICP dynamics are simultaneously need to be maintained [4,6,10]. We observe no intraoperative hypercyanotic spells occurred during the procedure, suggesting the effectiveness of our anesthesia approach to prevent possible complication and the multidisciplinary approach of our team.

The multidisciplinary involvement of anesthesiologist, neurosurgeon, and pediatric cardiologist is essential in achieving a favorable outcome. Preoperative optimization with antibiotics, beta-blockers, and correction of electrolyte imbalances reduces perioperative risks. Post-operative follow-up indicating neurological improvement and stable hemodynamics, with no new deficits at discharge and remarkable recovery on six-month follow-up. This case provides additional clinical insight into perioperative management when cardiac and neurosurgical condition must be addressed simultaneously. Specifically, it illustrates that low-dose ketamine, when titrated carefully along with controlled ventilation, may remain as a favoured option despite its theoretical contraindication for raised ICP cases.

Conclusion

The anesthesia management of patients with uncorrected ToF undergoing neurosurgery requires careful adjustment to both cardiac and cerebral physiology. In this case, the main challenge was maintaining SVR and preventing hypercyanotic spells while also maintaining ICP and preserving cerebral perfusion. Low-dose ketamine, combined with multimodal anesthesia and controlled ventilation, provided stable intraoperative hemodynamics with neither apparent neurological nor cardiac compromises. Multidisciplunary approach among anesthesiologist, neurosurgeon, and pediatric cardiologist play an important role as resulting in favorable perioperative outcome of our patient. This case supports the use of individualized anesthesia management in patient with complex condition.

Take-home message: even when conventional contraindications exist for ketamine use in raised ICP case, careful dose titration, multi-modal anesthesia, controlled ventilation, and multidisciplinary team is essential for avoiding potential risks and bring a favourable outcome for the patients such as in this case.

References

[1] Wilson R, Ross O, Griksaitis MJ. Tetralogy of Fallot. BJA Educ. 2019; 19:362-9.
[2] Lakhani M, Memon RS, Khan F. Brain abscess: A rare complication in a child with tetralogy of Fallot. IDCases. 2020; 22:e00954.
[3] Allman K, Wilson I, O'Donnell A. Oxford handbook of anaesthesia. Oxford University Press; 2015.
[4] Dwivedi P, Kumar S, Ahmad S, Sharma S. Uncorrected tetralogy of Fallot's: Anesthetic challenges. Anesth Essays Res. 2020; 14:349-51.
[5] Butterworth JF, Mackey DC, Wasnick JD. Morgan & Mikhail's clinical anesthesiology. McGraw Hill; 2022.
[6] Andre L, Perdhana F. Anesthetic management challenges in a patient with uncorrected tetralogy Fallot (TOF) and cerebral abscess. J Med Chem Sci. 2024; 7(7):881-5.
[7] Aditiarso C, Laksono BH. Perioperative management of neuroanesthesia in patients with supratentorial tumors who have excised tumors using neuroprotection technique and total intravenous anesthesia. J Anaesth Pain. 2024; 5(2):45-50.
[8] Wajekar A, Shetty A, Oak S, Jain R. Anaesthetic management for drainage of frontoparietal abscess in a patient of uncorrected Tetralogy of Fallot. Indian J Anaesth. 2015; 59(4):244-6.
[9] Nasr VG, Markham LW, Clay M, DiNardo JA, Faraoni D, Gottlieb-Sen D, et al. Perioperative considerations for pediatric patients with congenital heart disease presenting for noncardiac procedures: a scientific statement from the American Heart Association. Circ Cardiovasc Qual Outcomes. 2023; 16(1):e000113.
[10] Nwigwe NC, Adenekan AT, Faponle AF, Omon HE, Balogun SA, Anele CO, et al. Anaesthetic management for brain surgery in a child with uncorrected Tetralogy of Fallot in a resource-limited setting. Niger J Med. 2022; 31(3):343-6.