Case Report

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Case Study: Anesthesia for Congenital Cyanotic Heart Disease with Cerebral Abscess

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Abstract

Background: Congenital Cyanotic Heart diseases refer to a bundle of different heart defects that present at birth. The result is low blood oxygen level. Cyanosis refers to bluish coloration of skin and mucus membrane. The purpose of the study to disseminate our knowledge and experience of clinical characteristics, presentation and treatment of the issue for readers as future reference.

Case Presentation: In this case presentation, the anesthetic management of a 2 year old baby on 28th September 2024, in Chittagong Medical College Hospital, who was diagnosed with an untreated Tetralogy of Fallot (TOF) complication a brain abscess, is described. Given the intricate relationship between the child's cardiac and neurological conditions, the patient's presentation of a brain abscess necessitated cautious evaluation of anesthesia.

Conclusion: Specialized anesthetic techniques are vital for maintain hemodynamic stability, preventing additional hypoxemia and achieving successful operation.

Key words: CVP: Central Venous Pressure; CT: Computed Tomography; MRI: Magnetic Resonance Imaging; PVR: Pulmonary Vascular Resistance; PICU: Pediatric Intensive Care Unit; SVR: Systemic Vascular Resistance; SpO2: Oxygen Saturation; TOF: Tetralogy of Fallot.

Introduction

Brain abscess is a rarely occurring fatal complication accounting for 5%–18.7% of the population with cyanotic congenital heart diseases, Cyanotic heart diseases are associated with a right-to-left shunt that bypasses pulmonary circulation and results in tissue hypoxia and cyanosis.[1,2] The most common cyanotic congenital anomaly seen is the tetralogy of Fallot. The main predisposing factors for brain abscess are-

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- Right-to-left shunt that bypasses the pulmonary circulation, allowing bacteria to directly enter the systemic circulation without being filtered by the lungs, leading to seeding of the brain with bacteria which can then establish an infection within brain tissue,this creates a favorable environment for bacterial growth and abscess formation.
- Compensatory polycythemia (Increased red blood cell count) which increases blood viscosity and can further impair cerebral blood flow, creating areas of tissue hypoxia that are susceptible to infection.
- The chronic hypoxia associated with cyanotic heart disease can impair the immune response, making the brain more vulnerable to infection.
- Poor oxygenation due to the shunt can lead to small areas of brain ischemia, which act as potential sites for bacterial colonization and abscess formation.

Herein, we discuss a case of uncorrected tetralogy of Fallot presenting as a Right parieto-occipital abscess in a 2-year-old child, planned for Craniotomy under G/A.

Case Presentation

Master 'M' 2 years 4 months of age hailing from Fatikchari Chattogramadmitted on 25th September, 2024 was diagnosed as right parieto occipital abscess and planned for craniotomy under general anesthesia.

According to his father's statement he had been suffering from lethargy and weakness for about 10 days.He also mentioned,the patient was unable to stand and walk alone for about 6 weeks and falling multiple teeth, along with low grade fever for last few weeks. So, he met with his doctorwho diagnosed his bluish discoloration and advised him to do an echocardiography, chest x-rayfor that reason. Pediatriccardiologistdiagnosed his congenital heart disease, that was Tetralogy of Fallot with Good bi ventricular function after echocardiography and advised to do CT scan and ultrasonography of the brain followed by MRI of brain which revealed large right cerebral

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multiloculated abscess with mass effect. So, he was diagnosed as a patient of cerebral abscess which was in right parieto-occipital region due to TOF. In Chittagong Medical College he was planned for craniotomy under general anesthesia.

In pre anesthetic checkup his chest X-ray revealed he has boot shaped heart and he was suffering from cyanosis and clubbing. His ASA grading was 2. Heart sounds 1 and 2 werewith an ejection systolic murmur best heard at the left upper sternal border.Heart rate was 112 bpm.

Respiratory system examination showed, non-invasive blood pressure was 90/50 mm of Hg, RR: 36 bpm, SpO_2 : 92% without oxygen support. No respiratory distress, equal air entry, bronchovesicular breath sounds.

Figure 1 Chest X ray P/A view showing boot shaped heart

He was under broad spectrum of antibiotics, including Vencomycin and Meropenam, which was selected empirically. There was hyponatremia (132 mmol/l) and hypokalemia (3.07 mmol/l), blood picture also showed microcytic hypochromic blood picture with neutrophilic leukocytosis. Bleeding Time (1min 20 sec) Clotting Time (7 min) Renal function (Creatinine-0.15mg/dl) and other screening test was satisfactory. So, operation was scheduled on 28th September, 2024, after correction of dyselectrolytemia and anemia. 200 ml AB (+) ve whole blood was kept ready. Patient was kept nothing solid per oral for 4 hours and without liquid for 2 Hours. A written consent wasobtained after proper elaboration of the General Anesthesia and possible outcome was explained. PICU was also informed.

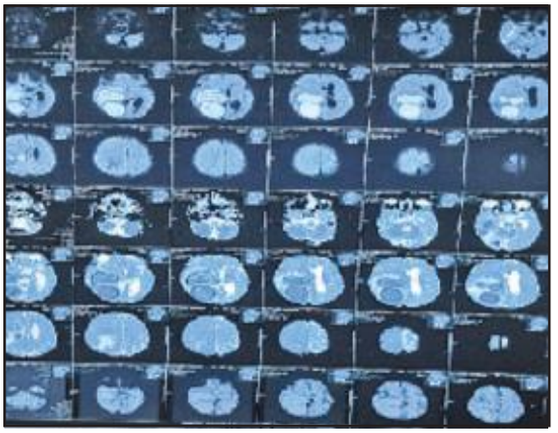

Figure 2 Axial brain MRI showing a well-defined, thin-walled lesion in right temporo-parietal region with midline shift

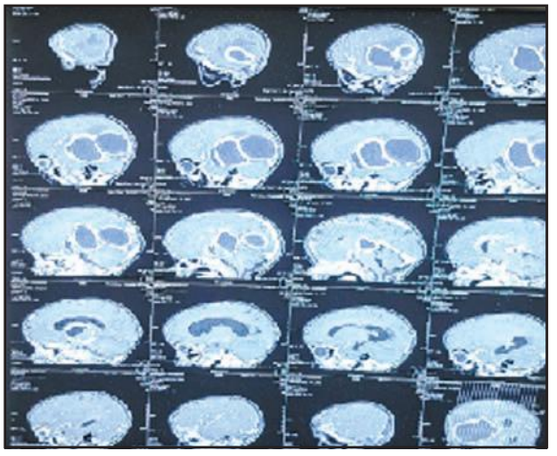

Figure 3 Sagittalimage showing multiple rings enhancing lesions in right parietal and occipital lobe

Intraoperative Management

On 28th September, 2024 Master M was shifted to theoperation theater, and weighed 9kg. Monitors attached and vitalswere recorded. Peripheral venous access securedby using 22G I/V cannula on the right forearmunder all aseptic precaution. Though we have no video laryngoscope, we emphasized on

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Miller Laryngoscope instead of Macintosh. Induction agent was Ketamin 20mg, 36 unit of suxamethonium and 20 units of fentanyl,80 units of Vecuronium was used for maintenance of muscle relaxation and isoflurane was 0.8. The patient was intubated with a 3.5 cuff ETtube with a lip margin of 18 cm. Entonox (O_2 :N_2O= 50 : 50) was chosen initially, later we changed it to 100% oxygen to maintain SpO_2. Per operative saturation was 88-92%, heart rate was 110-130 bpm. Total duration of Anesthesia was 2 hours since induction at 9.15 am. He was infused with 80 ml of ¼th dextrose containing normal saline (Baby saline) in that period. We provided peri operative ketamine intermittently (10 mg in 30 minutes interval, total 20 mg)at rate of 20µgm/kg/min (Dose- 15-30µgm/kg/min).[3] Duration of surgery was 1hour 35 minutes. During the operation, the patient's systolic blood pressure was 83 to 110 mmHg, diastolic 50 to70 mmHg, pulse rate was 90-100bpm.Alpha Adrenergic agonist drugs as phenylephrine, ephedrine or ionotropic agents as nor-adrenaline, dopamine, adrenaline was kept ready to treat undesirable decrease in systemic blood pressure. Ventilation was controlled. Temperature of operation theatre was controlled within 22° to 25° centigrade and proper wrapping was ensured to prevent hypothermia. Maintaining aseptic precaution, U shaped incision was given on scalp and after craniotomy dura incised. Then the abscess lesion located and pus aspirated, bones positioned and wound closed in layers with a drain in situ. After completion of the operation, extubation was done at 11.15 am. and observation were carried out in the post operative room for 3 hours. Postoperative analgesia included iv paracetamol (100 mg) and ketorolac (45 unit in 100unit insulin syringe). After observing for 3 hours in the recovery room, the patient was transferred to the High Dependency Unit (HDU) of Neurosurgery Ward where he underwent three-days treatment by observing post-op breathing patterns, temperature and pain level along with wound healing and overall wellbeing. His recovery was satisfactory with minimum drain tube collection (4cc after 48 hours).

Discussion

The anesthetic management of patients with congenital heart defects, such as Tetralogy of Fallot (TOF) presents unique challenges. The prevalence of brain abscesses is approximately 8% of intracranial masses in developing nations, while in Western countries, it is around 1–2%.[4] Brain abscess patient with TOF require careful attention to hemodynamics and oxygenation during anesthesia. Below are the key considerations and management strategies in this case.

Anesthetic Goals in TOF Patients: -

The primary anesthetic goals for patients with Tetralogy of Fallot and brain abscess are:

- **Avoiding Hypoxemia**-Maintaining adequate oxygenation is crucial to prevent exacerbation of the right-to-left shunt.
- **Ensuring Adequate Hydration-**To prevent hypovolemia, which could increase the magnitude of the shunt.
- **Maintaining Systemic Arterial Blood Pressure (SVR)-**Preserving SVR is essential for ensuring adequate oxygen delivery and preventing worsening of the shunt.
- **Minimizing Pulmonary Vascular Resistance (PVR)-**Avoiding increases in PVR is critical to minimize the risk of worsening oxygenation and increasing the right-to-left shunt.
- **Avoiding Sudden Increases in Systemic Oxygen Demand-**Any stress or sudden change in demand could worsen the hemodynamic status.

Induction of anesthesia in patients with TOF can lead to vasodilatation, resulting in decreased SVR. This may worsen the right-to-left shunt and compromise oxygenation. To mitigate this, ketamine was chosen as the induction agent. Ketamine is known for its ability to increase SVR and improve oxygenation by decreasing the magnitude of the right-to-left shunt.[5] Short acting depolarizingmuscle relaxant (Suxamethonium) was used to achieve adequate muscle relaxation.

For maintenance of anesthesia, a combination of nitrous oxide and ketamine was used. The rationale for this combination is as follows:

- **Ketamine:** Provides additional support for maintaining SVR and ensures analgesia.
- **Nitrous Oxide:** While nitrous oxide can increase PVR, it also preserves SVR. This balance helps to improve hemodynamics.

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However, the primary disadvantage of nitrous oxide is its potential to decrease the inspired oxygen concentration, which may compromise oxygenation. To minimize this risk, we limited the inspired concentration of nitrous oxide to 50% (2 L/min) i.e. Entonox to prevent further decreases in oxygen levels while still preserving SVR.[6]

Despite the controlled administration of nitrous oxide and oxygen, the patient's SpO_2 dropped to 85%, signaling inadequate oxygenation. In response, we transitioned to 100% oxygen, which resulted in an improvement in oxygen saturation (SpO2) to 90-93%. This was maintained throughout the surgery, ensuring adequate oxygenation for the duration of the procedure.

Careful selection of a non-depolarizing neuromuscular blocking agent is essential, as some agents, when administered rapidly and in high doses, can induce histamine release. This release can cause a decrease in SVR and systemic blood pressure, potentially worsening hemodynamics. Vecuronium was used as the neuromuscular blocker in this case due to its favorable profile in maintaining stable vascular resistance and blood pressure.Careful consideration shouldbe given in avoiding histamine releasewhich is associated with reducing SVR and SBP.[6]

Acute hypovolemia can exacerbate the right-to-left shunt in TOF patients, while permissive hypervolemia may increase the risk of pulmonary congestion and exacerbate right heart failure. Therefore, meticulous attention was given to the patient's hydration status, with careful management of intravenous fluids to avoid both hypovolemia and hypervolemia.[6]

Controlled ventilation was used to optimize oxygenation while avoiding exce8ssive positive pressure, which can increase PVRand worsen the right-to-left shunt. The goal was to balance ventilation pressures carefully to minimize the risk of complications while ensuring adequate gas exchange. Keeping PCO_2 in (Normocapnia) limit was an agenda during ventilation.[6]

Active warming measures were implemented to prevent hypothermia, as this can increase pulmonary vascular resistance and further compromise oxygenation.[7]

Anesthetic management of patients with brain abscess and Tetralogy of Fallot requires a carefully orchestrated approach to preserve hemodynamics, optimize oxygenation and minimize the effects of the right-to-left shunt.[8] The anesthetic management of patients with these conditions is a continual challenge for anesthetists due to cardiac and coagulation issues, dehydration, electrolyte imbalance, and abscess-related complications such as seizures, meningitis, and high intracranial pressure.[4] By using ketamine for induction, a combination of nitrous oxide and oxygen for maintenance and meticulous fluid and ventilation management, we were able to successfully manage this patient's anesthesia needs and achieve a stable outcome throughout the procedure.

Conclusion

This case report underscores the challenges and considerations involved in the anesthetic management of a pediatric patient with Tetralogy of Fallot undergoing neurosurgery for cerebral abscess excision. Through a meticulously planned and executed anesthetic strategy—with an emphasis on maintaining hemodynamic stability, normocapnia, and normothermia—author achieved a successful outcome without intraoperative or postoperative complications. This case reinforces the importance of multidisciplinary collaboration and individualized anesthetic planning in managing complex pediatric patients with cyanotic heart disease.This Issue emphasizes how crucial customized anesthetic techniques are to preserving hemodynamic stability, halting more hypoxemia, and guaranteeing a successful surgical outcome.

Recommendation

More cases like this issue can help us to compare, optimize and upgrade the existing management protocol.

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Disclosure

All the authors declared no conflict of interest.

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