# Anesthetic Management in a Pediatric Patient with Cyanotic Congenital Heart Disease and Cerebral Abscess: A Case Report

Irwan Setiadi [1], Muhammad Rezanda Alifahna [1*], Radian Ahmad Halimi [1], Dewi Yulianti Bisri [1]

## Abstract

Backgorund: Cyanotic congenital heart disease (CHD) is associated with more than 60% of brain abscess cases. The incidence of brain abscess is approximately 8% of intracranial masses in developing countries, with variable clinical manifestations related to space-occupying lesion (SOL) size and location. Brain abscesses often cause elevated ICP and are associated with very high morbidity and mortality. Case Presentation: A 7 years old boy, with multiple space-occupying lesions supratentorial, Ventricular Septal Defect, and pulmonary hypertension had to undergo burrhole aspiration. The patient was placed on an IV line in three ways. Maintenance fluids are given with ringerfundin 56 cc/hour intravenously while monitoring consciousness, vital signs, and blood sugar. Preoxygenation was carried out, induction with Midazolam 0.1-0.2 mg IV (2 mg), Fentanyl 2 mcg/kg IV (20 mcg), and Rocuronium 0.6 mg/kg IV (5 mg). Intubated using video laryngoscope ETT number 5. Anesthesia maintenance with 1-2 vol% sevoflurane. Administered O2 with 50% FiO2 air. Discussion: Anesthesia management in patients with cyanotic CHD begins with a thorough pre-anesthetic assessment documenting current cardiac and neurological status, previous surgery, previous anesthesia management, complications, and current treatment. The two main principles of perioperative risk management are the prevention of systemic hypotension and avoidance of increased PVR (PH crisis). Conclusion: A well-executed general anesthetic with hemodynamic maintenance aimed at preventing the occurrence of worsening right-to-left heart shunts, and maintaining good intracranial pressure has a fairly good outcome in patients with suspected cerebral abscess with congenital heart disease. Preparation for emergency events is always needed and done to reduce the morbidity and mortality. Post-operative management includes intensive cardiac monitoring, oxygenation, appropriate analgesia, fluid management, and prophylaxis of vomiting and seizures. Patients reported had normovolemic in the postoperative period and resumed oral intake as soon as possible.

**Keywords:** Anesthesia management; Cerebral abscess; Congenital Heart Disease; General anesthesia; space-occupying lesion

***Significance*** | Understanding anesthetic management in congenital heart disease patients undergoing intracranial surgery aids in reducing perioperative morbidity and mortality.

*Correspondence. Muhammad Rezanda Alifahna, Department of Anesthesiology and Intensive Care, Faculty of Medicine, Universitas Padjadjaran, Jl. Pasteur No.38, Bandung, 40161, West Java, Indonesia.
Phone: +62 813 1322 2296
E-mail: muhammadrezanda@gmail.com

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## Introduction

Congenital heart disease is defined as an abnormality in the structure or function of the cardio-circulation that is found at birth, or even found later in life. Congenital heart disease can be categorized as cyanotic or asianotic. Cyanosis refers to a blue-violet discoloration of the skin and mucous membranes caused by an increase in the blood concentration of deoxygenated hemoglobin. Asianotic lesions include intracardiac or vascular stenosis, valve regurgitation, and defects that cause blood to shunt from left to

**Author Affiliation.**
[1] Department of Anesthesiology and Intensive Care, Faculty of Medicine, Universitas Padjadjaran, Bandung, Indonesia.

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right.(Lilly, 2012; Zipes, 2018) VSD is one of the most common forms of asianotic congenital heart disease. VSD has a percentage of 35% of cases of congenital heart disease. The physiological consequences of VSD will depend on the type of defect, the size of the defect as well as the presence or absence of shunting in the patient. shunting from right to left will be influenced by pulmonary vascular resistance as well as systemic. If the defect is small in size, there will be only a slight increase in blood flow to the lungs (Lilly, 2012; Zipes, 2018).

More than 60% of cases of congenital heart disease are related to brain abscesses. In developing countries, the incidence of brain abscesses is around 8% of the number of cases of intracranial masses with clinical symptoms that vary depending on the size and location of the space-occupying lesion (SOL). Increased intracranial pressure is a common result of brain abscesses, as well as increased morbidity and mortality(Zipes, 2018). The main factor causing the formation of a brain abscess is hypoxia because anaerobic bacteria are the most commonly found organisms from abscess culture and the second is hyperviscosity due to reduced microcirculatory flow resulting in micro or macro infarction plus a source of infection in slow blood flow forming focal cerebritis followed by abscess. Brain abscesses often lead to increased intracranial pressure and have very high morbidity and mortality rates especially in developing countries (Lilly, 2012).

Anesthetic management in patients with cyanotic congenital heart disease has its challenges because it must anticipate shunting that can occur before surgery, intraoperatively, or post-operatively. Increased shunting in patients with cyanotic congenital heart disease such as patients with ventricular septal defects (VSD) accompanied by pulmonary hypertension can occur due to reduced systemic vascular resistance, elevated pulmonary vascular resistance, and elevated myocardial contractility (Bokhari & Mesfin, 2017). The selection of an anesthetic agent is a challenge because in this case it must prevent an increase in cerebral blood flow so that there is no increase in intracranial pressure (Lovell, 2004). Selection of doses of anesthetic agents should be considered so as not to cause a surge in hemodynamics that will affect congenital heart disease and cerebral blood flow that will have an impact on complications during surgery (Kaplan et al., 2016).

Intraoperative monitoring in this case has challenges due to limited facilities. Monitoring includes blood pressure, pulse, temperature, as well as EtCO2 in patients (Marwali et al., 2017). The principle of monitoring during intraoperative is to prevent things that will cause an increase in the PVR and a decrease in the SVR (Gottlieb & Andropoulos, 2013). Hypoxia, hypercarbia, and acidosis can cause significant increases in PVR that require intraoperative monitoring (Walker et al., 2021). Preventing hemodynamic spikes during surgery is important to keep cerebral blood flow and cardiac blood flow stable (Cannesson et al., 2009). Postoperative care needs to be considered to prevent complications (Wijesingha & White, 2015). Early extubation is an option in these patients in order to prevent an increase in PVR (Houck et al., 2014). Multimodal analgesia in the form of opioids and paracetamol are given to patients to prevent postoperative hemodynamic spikes caused by inadequate pain management (Kaye et al., 2012).

This case report aims to discuss anesthetic management in patients with multiple supratentorial SOL at the right frontal due to a suspected cerebral abscess, accompanied by VSD and pulmonary hypertension. This patient will undergo abscess drainage.

**Case Report**

A 7-year-old boy came with complaints of intermittent headaches for the past 1 month. Other complaints such as nausea, vomiting, and decreased consciousness were denied. The patient previously had a history of cyanosis and intermittent shortness of breath since birth due to a history of congenital heart disease. On physical examination, the patient was found to be compos mentis, blood pressure 100/60 mmHg, pulse 114 times per minute regular, respiration 28 times per minute, temperature 36.6 degrees Celsius, oxygen saturation 78-82% in room air. Other examinations revealed central and peripheral cyanosis, murmurs on cardiac examination, and clubbing fingers on extremity examination. Laboratory examination revealed Hb 18.4 g/dL, Ht 53.9%, Leukocytes 10.860 uL, Platelets 340.000 uL, PT 13.2 second, INR 0.96, APTT 29.70 second, Sodium 137 mEq/L, Potassium 4.7 mEq/L. A chest x-ray examination showed cardiomegaly, and an echocardiography examination revealed a large VSD with a balanced shunt accompanied by pulmonary hypertension. A CT scan of the head revealed a hypodense lesion in the right frontal area accompanied by compressed gyrus sulcus, periventricular edema, and a midline shift >5 mm to the left (Figure 1. CT scan of the head revealed a hypodense lesion in the right frontal area accompanied by compressed gyrus sulcus, periventricular edema, and a midline shift >5mm to the left).

Before surgery, patients were fasted for 6 hours and given maintenance fluids using crystalloids. The patient was confirmed to be in a state of euvolemia before surgery. The patient was given premedication using midazolam 0.05 mg/kg per dose before entering the operating room. Induction was carried out with midazolam 0.1 mg/kg per dose, fentanyl 3 mcg/kg per dose, and rocuronium 0.6 mg/kg per dose. The patient was intubated using direct laryngoscopy using a number 5 non-king endotracheal tube. Maintenance of anesthesia with sevoflurane 1-2 vol%.

During surgery, the patient's hemodynamics were stable with systolic blood pressure ranging between 85-95 mmHg, diastolic blood pressure ranging between 56-61 mmHg, pulse 99-110 beats per minute, and saturation 84-91% (Figure 2).

The patient was extubated post-operatively and fully monitored in the High Care Unit. Next, the patient's consciousness, vital signs,

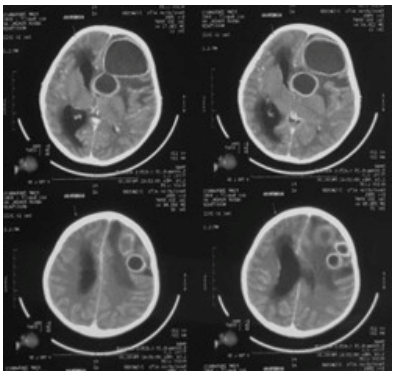

**Figure 1.** CT scan of the head revealed a hypodense lesion in the right frontal area accompanied by compressed gyrus sulcus,periventricular edema, and a midline shift >5mm to the left.

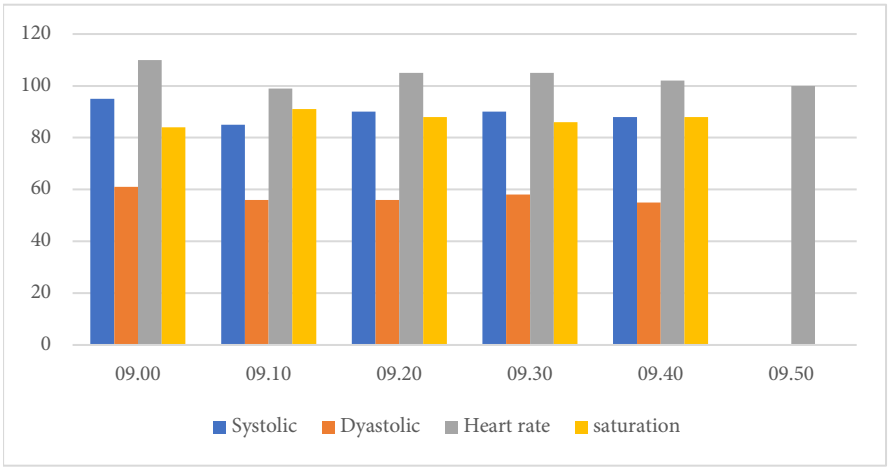


**Figure 1.** Intraoperative Hemodynamic Chart

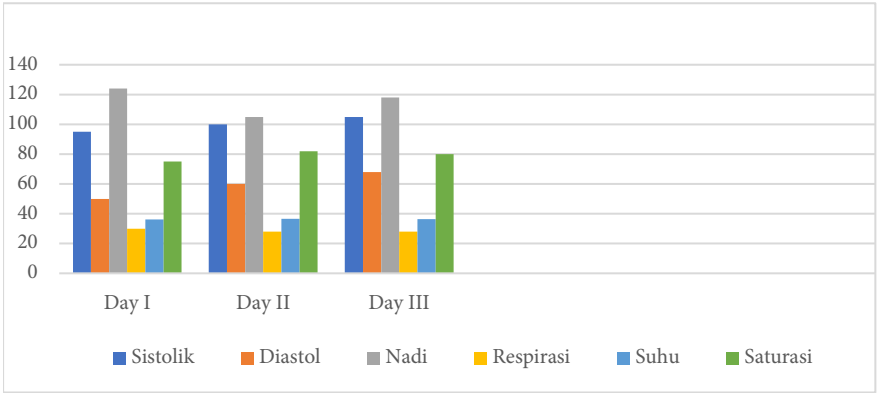


**Figure 3.** Postoperative Hemodynamic Chart

and postoperative complications are observed. Postoperative - The patient is performed postoperative extubation and postoperative care is carried out to a semi-intensive room. Observation of consciousness, vital signs, and postoperative complications is carried out (Figure 3).

**Discussion**

There are several reasons some patients with congenital heart disease are only diagnosed as adults, but the most common cause is late diagnosis because it is often asymptomatic. Complaints or symptoms usually only appear after an imbalance between the systemic and pulmonary circulation. The condition of patients with congenital heart disease such as VSD that has been prolonged causes some changes in the physiological condition of the body and causes adjustments to several systems such as chronic hypoxia and also changes in blood flow in the lungs. (Cannesson et al., 2009; Marwali et al., 2017)

The challenge of anesthesia in these patients is to combine the understanding of the pathophysiology of congenital heart disease and neuroanesthesia techniques (Nashat et al., 2017). The principle of anesthetic management for cyanotic congenital heart disease, such as in patients with VSD, is to prevent reverse blood flow or shunting from the right heart to the left heart by preventing a decrease in systemic vascular resistance (SVR) and preventing an increase in pulmonary vascular resistance (PVR) (Wajekar et al., 2015). The main goals of anesthetic management in VSD patients are to maintain intravascular volume status during surgery and maintain systemic vascular resistance. Induction can be carried out using inhalation with sevoflurane or halothane gas. Sevoflurane does not have a direct impact on the relationship between SVR and PVR because it can cause a decrease in SVR and PVR (Bennet et al., 2021).

SVR is comparatively more steady when halothane is used and can lead to a more negative inotropic effect, thereby reducing the effects of infundibular spasms. However, this effect is less desirable because it causes arrhythmia. Halothane caused a greater reduction in heart rate and cardiac index than sevoflurane, therefore in this patient treatment with the agent sevoflurane was used. Maintenance anesthesia can be done with inhalation anesthesia or total intravenous anesthesia (TIVA) or both. It is necessary to administer neuromuscular agents for muscle relaxants and switch to positive pressure ventilation(Setiandari et al., 2023).

In this case report , the patient was preoxygenated before induction using Midazolam 0.1-0.2 mg IV (2 mg), Fentanyl 3 mcg/kg IV (30mcg) and Rocuronium 0.6 mg/kg IV (5 mg). Until now, the relationship between anesthetic agents to hemodynamic changes is still being studied, until now, the anesthetic agent that is known to be able to maintain hemodynamic stability in patients with congenital heart disease is etomidate. The anesthetic formulation in this case used is sevoflurane. Sevoflurane does not affect the relationship of SVR to PVR too much because it lowers not only SVR but also PVR.

Intraoperative Shunting can be caused by many things, one of which is an anesthetic agent, in addition to the presence of air bubbles can also cause sudden shunting. Ventilation strategy, patient position, bleeding also affect blood flow in the heart. ventilation with high airway pressure can affect blood flow back, increase vascular resistance and trigger right to left shunting in cases of cyanotic heart disease. Inadequate anesthesia as well as sympathetic stimulation can increase systemic resistance and change shunting to left to right and decrease blood flow out of the heart, especially in patients with ASD. Tredelenburg's position may increase pressure in the superior vena cava and cause hypoperfusion of the cerebri in patients with glenn shunt or fontan.(Cannesson et al., 2009; Lovell, 2004)

Hypoxia, hypercarbia, and acidosis can cause significant increases in PVR. Norepinephrine can help maintain SVR and epinephrine and/or vasopressin can be used if needed during surgery. Ketamine as a single anesthetic induction is contraindicated in intracranial surgery because it can increase blood flow to the brain and increase intracranial pressure in the patient. Due to its cardiostability and short duration of action, TIVA with fentanyl may be considered. Increased PVR due to prolonged ventilation can be prevented with early extubation. Postoperative care includes intensive cardiac monitoring, oxygenation, appropriate analgesia, fluid management, and vomiting and seizure prophylaxis. Patients need to be normovolemic in the postoperative period, and oral intake should be resumed as quickly as feasible. Pain management is crucial for maintaining adequate ventilation; however, opioids must be administered with caution to avoid excessive sedation and hypoxia. Hypoventilation, hypoxemia, arrhythmias, and inadequate postoperative pain management can lead to exacerbation of the patient's shunt, which can lead to cardiac decompensation (Novick et al., 2022).

**Conclusion**

The aim of anesthetic management in patients with cyanotic congenital heart disease who will undergo intracranial surgery is to maintain intravascular volume, prevent a decrease in SVR, prevent an increase in PVR, and consider the choice of anesthetic technique and drugs to prevent an increase in cerebral blood flow which will increase intracranial pressure.

**Author contributions**

I.S. conceived and designed the study, and also reviewed and edited the manuscript. M.R.A. conducted the literature search and drafted the original manuscript. R.A.H. provided conceptualization and supervised the study.

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## Competing financial interests

The authors have no conflict of interest.

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