Case Report

Anesthesia for Laryngotracheal Reconstruction in a Child with Single Ventricle

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ABSTRACT

The number of children with congenital heart requiring anesthetic care is increasing. We describe the anesthetic management of a child with single ventricle candidate for laryngotracheal reconstruction. The patient suffered from severe subglottic stenosis due to prolonged intubation following Glenn shunt procedure. Anesthetic considerations in the care of patients with single ventricle for non-cardiac surgeries are reviewed. Particular concerns in the airway management of children with severe subglottic stenosis and during the tracheal surgery are also reviewed.

Keywords: Airway management, anesthesia, congenital heart disease, single ventricle

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INTRODUCTION

Patients with single ventricle are a challenging subgroup of congenital heart disease (CHD) who require multiple palliative procedures until adulthood.[1] These patients often require airway procedures as an adjunct to their care.[2] Anesthesiologists should therefore be familiar with the principles of anesthetic management, postoperative care and outcomes in this subset of patients. This manuscript presents the anesthetic management of a child with single ventricle candidate of laryngotracheal reconstruction.

Case Report

A 1½-year-old female child was admitted for intolerance to tracheostomy tube removal following Glenn shunt procedure [Figure 1]. On admission, the baby was somewhat cyanotic with an oxygen saturation of 76% with a stable hemodynamic profile. Echocardiography reported globally estimated ejection fraction 45% and open Glenn pathway. The treatment plan for this patient included three steps of initial airway assessment, laryngotracheal reconstruction and follow-up assessment.

Initial airway assessment

After standard monitoring, inhalation induction with sevoflurane was applied at the tracheostomy site. On fiberoptic examination, the motion of the vocal cords was normal but a subglottic stenosis grade 4 was observed. [Figure 2] On assessment through the tracheostomy stoma, a posterior bulging of the trachea distal to the stenosis was detected. As vascular anomalies compressing the airway in the setting of CHD are likely, the child was referred to perform a CT angiography. The report of angiography ruled out vascular anomalies with compressing effect on the trachea.

Laryngotracheal reconstruction

The child was kept fasting for 6 hours before surgery, but hydrated with infusion of normal saline at 40 ml/h

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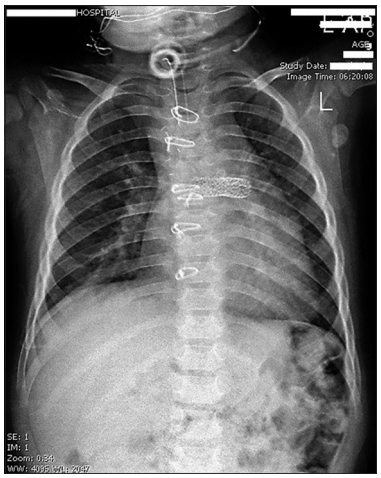

Figure 1: Chest X-Ray several months after Glenn shunt procedure with tracheostomy in place

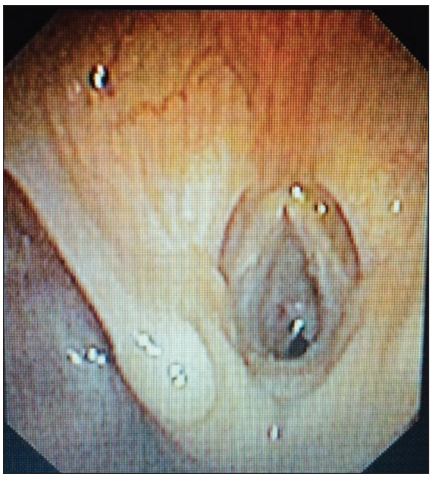

Figure 2: Severe subglottic stenosis identified in fiberoptic examination

intravenously. Standard monitoring plus radial artery cannulation in the right hand for blood pressure measurement and blood gas analysis were implemented. The child was premedicated with fentanyl 20 μg and midazolam 0.5 mg. General anesthesia was induced with intravenous ketamine 10 mg and inhalation of sevoflurane 3%. Muscle relaxation was achieved with atracurium 5 mg. Tracheostomy tube was replaced with a cuffed endotracheal tube N 4 over a pediatric size bougie. Anesthesia was maintained with sevoflurane and atracurium. Hemodynamic profile was stable during the surgery and oxygen saturation increased to 84%. Arterial blood gasses were within normal limits. Muscle relaxation was reversed with neostigmine and atropine. The child was transferred to intensive care unit (ICU) on oxygen via T-piece without the need for ventilator support. She was stayed in the ICU for 48 hours and was then transferred to the ward. The patient was discharged five days after surgery. The surgery and postoperative period were uneventful.

For laryngotracheal reconstruction, the cartilage of the fifth rib was harvested. Through collar incision, subplatysmal flaps were elevated. The cricoid was split from the middle and upper and lower parts of the cricoid were transected. Severe stenosis with approximately 1 cm length was detected. By longitudinal cut of the posterior cricoid, the shaped rib cartilage graft was inserted between the external perichondrium and cricoid lamella. A 1cm length cut of an endotracheal tube size 2 was inserted as a stent. The anterior cartilage graft was inserted and strap muscles were sewn. Finally, the skin was brought together.

Follow-up assessment

One month later, laryngoboronchoscopy was performed using minimal required doses of fentanyl, midazolam and sevoflurane. On assessment, the airway was open and only a trivial granulation tissue was seen at the site of tracheotomy. The stent removed under general anesthesia and the tracheotomy tube replaced. One week later tracheostomy tube was removed in the operating room under monitored anesthesia care and stoma closed. The child's condition was satisfactorily on 6 months follow-up. She was still slightly cyanotic but without respiratory distress or airway complaint and tolerated walking short distances and even running a few steps. Weight gain was acceptable and swallowing difficulty was not reported.

DISCUSSION

The incidence of tracheal stenosis following prolonged intubation has significantly decreased due to improved endotracheal tube management protocols.[3] However, pediatrics with CHD have several risk factors for the development of this complication in their course of treatment. Young age, prolonged cardiopulmonary bypass and prolonged postoperative mechanical ventilation are among the main precipitating factors.[4] The estimated incidence of subglottic stenosis in children younger than 2 years following repair of congenital heart defects is more than 2%.[5] Airway surgery in a pediatric patient with residual heart defect is a real challenge for every anesthetist.

No one anesthetic technique or medication has proven to be superior in patients with single ventricle. The objectives of intraoperative management are maintaining cardiac contractility, balancing the systemic and pulmonary vascular resistance, preventing dysrhythmias, and optimizing oxygen saturation.[6,7] We used ketamine and sevoflurane for induction and maintenance of anesthesia. Ketamine probably increases pulmonary vascular resistance. However, it similarly increases systemic vascular resistance that

offsets pulmonary vascular increases. It may also improve oxygenation due to increased contractility of right ventricle helping to push blood across the anomalous obstruction.

In patients with cyanotic heart disease, pharmacokinetic of volatile anesthetics is not significantly altered. These agents decrease systemic vascular resistance in favor of maintaining the balance between systemic and pulmonary perfusion.[8] Sevoflurane with its rapid offset and diminishing effect on heart rate might be a desirable choice. Other parameters with the potential to affect this balance are Po2, Pco2, pH, body temperature, intrathoracic pressure and endogenous catecholamines released due to pain or stress response. Hypovolemia is poorly tolerated and hypotension or cardiac dysrhythmias, especially tachycardia, should be treated invasively.[9] Thromboembolism and ventricular dysfunction are other concerns in these patients.[10]

Vascular anomalies such as double aortic arch can compress the trachea and mimic subglottic stenosis in patients with CHD.[11] This possibility should be considered in the preoperative assessment of patients with the symptoms of airway compromise.[12] Another concern with these vascular anomalies is the possibility of tracheomalacia,[13] which could endanger tracheal patency even after successful augmentation surgery. In our patient suspicious bulging of the trachea distal to the stenosis necessitated further radiologic assessment; the result was normal.

Finally, children with single ventricle candidate for non-cardiac procedures require multidisciplinary decision-making and optimal communication among surgeons, anesthesiologists, and pediatric cardiologists for optimizing outcomes. The keys of uneventful intraoperative management are paying attention to the pharmacological effects of anesthetics in such a physiologic condition, maintaining normovolemia, preventing acidosis and optimizing oxygenation. Combined use of ketamine and sevoflurane can provide a stable hemodynamic profile and improve oxygenation in patients with single ventricle during non-cardiac surgeries. Maintenance of spontaneous ventilation is another advantage, when required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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