Anesthetic considerations for video-assisted thoracoscopic surgery in a child with Glenn shunt for thoracic duct ligation and pleurodesis

ABSTRACT
Glenn shunt is an anastomosis between superior vena cava and right pulmonary artery to palliate patients with single ventricle physiology of the heart. Chylothorax is a frequent and troublesome complication after the creation of this shunt, which if not controlled with medical management, might require pleurodesis, and thoracic duct ligation. Video-assisted thoracoscopic surgery (VATS) causes less postoperative pain, earlier mobilization, lower overall morbidity, a shortened hospital stay with reduced cost, and a cosmetic incision. A comprehensive understanding of physiology of Glenn shunt and implications of the proposed surgical procedure (VATS) is necessary to plan the anesthetic agents, cardiovascular drugs, ventilation strategies, and other perioperative factors.

Key words: Chylothorax; Glenn shunt; pleurodesis and thoracic duct ligation; video-assisted thoracoscopic surgery

Introduction
Surprising advances in the refinement of video technology have allowed the rapid expansion in video-assisted operative approaches in nearly all surgical areas and video-assisted thoracoscopic surgeries (VATS) is no exception. Our case is rare and unique as it included the anesthetic management of a child with Glenn physiology (with already compromised single ventricle physiology with saturation ranging 80%–90%) for VATS surgery for thoracic duct ligation and pleurodesis.

Case Report
A 1½-year-old male child was posted for VATS for thoracic duct ligation and pleurodesis in view of persistent chylothorax after the child underwent Glenn shunt for transposition of the great vessels with tricuspid atresia and pulmonary stenosis. He was put on tablet ecosprin37.5 mg, injection (intravenous [IV]) lasix 3 mg, medium chain triglyceride (MCT) oil, tablet sildenafil 2.5 mg thrice a day, octreotide 80 micrograms subcutaneously thrice a day, multivitamins, and broad spectrum antibiotics initially to resolve chylothorax by medical management. Simultaneously, bilateral intercostal drains were placed to drain chyle from both the sides. On clinical examination, the child had puffy face with heart rate 100/min, blood pressure (BP) 70/38 mmHg, respiratory rate of 30/min, arterial oxygen saturation (SpO₂) on room air varying between 84% and 88%. All biochemical investigations including arterial blood gas analysis were within normal limits. Chest X-ray was suggestive of widened mediastinum, and bilateral chest drains in view of bilateral pleural effusion.

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chylothorax [Figure 1]. Preoperative cardiac consultation was sought and echocardiography revealed normal patent pulsatile Glenn shunt [Figure 2]. The appropriate risk consent was taken from parents and bed ventilator was arranged for the child. The child had 24-gauge cannula in dorsum of the left hand, modified rapid sequence induction was done with preoxygenation, IV fentanyl 15 µg, etomidate and succinylcholine, and trachea was intubated with 4.5 uncuffed endotracheal tube. Anesthesia was maintained with 2%-3% sevoflurane in oxygen with top up doses of atracurium. Intraoperative monitoring included heart rate with rhythm analysis, noninvasive blood pressure, arterial saturation, end tidal carbon dioxide, temperature, invasive BP monitoring through the left posterior tibial artery cannulation, central venous access through the right femoral vein. The patient was positioned in left lateral decubitus for right‑sided VATS. Intraoperatively, surgeons were not able to identify the thoracic duct due to dextrocardia and anatomical difficulties and did successful pleurodesis on the right side with talc and doxycycline. The patient remained hemodynamically stable intraoperatively, and maintained SpO₂ between 85% and 98%, during the entire period which lasted for 2 h and total IV fluid was 160 ml with clear urine output of 40 ml. Intraoperative analgesia was provided with fentanyl boluses, and intercostal nerve block was given by surgeons for postoperative analgesia. The child was extubated uneventfully at the end of the procedure in operation theater and was monitored in pediatric Intensive Care Unit and remained hemodynamically stable. He was shifted to pediatric ward after 24 h and has been doing well since then.

Discussion

Congenital heart disease such as transposition of great vessels and tricuspid atresia are mostly not amenable to full anatomical correction and are palliated by creating a single ventricle pathway. The single ventricle pumps blood to the body and venous return from upper body comes passively into bilateral lungs through bidirectional Glenn anastomosis between superior vena cava and right pulmonary artery, pulmonary venous return coming back into the left atrium where mixing takes place. The child remains cyanosed after this procedure (SpO₂ 75%–85%). Chylothorax is a frequent and troublesome complication associated with congenital heart surgery, with an incidence of 0.5%–6.5%. It may be caused either by injury of the thoracic duct or increased pressure in the systemic veins exceeding that in the thoracic duct. Proposed treatment strategies which aim to decrease or stop the lymphatic lymph flow are: long chain fatty acid‑free, MCT enriched diet, total parenteral nutrition, octreotide therapy, optimization of hemodynamics (recanalization of closed central veins), or closing the leakages by suprarenal ligation or pleurodesis. Pleurodesis and closure of thoracic duct are preferred by VATS surgery over open thoracotomy as VATS causes less postoperative pain, allows early mobilization, lower overall morbidity, a shortened hospital stay, and a cosmetic incision. One‑lung ventilation (OLV) with “lung isolation” is indicated to protect the nondiseased contralateral lung from contamination all these can have a significant adverse effects on the cardiopulmonary physiology which can aggravate the pathophysiological changes already present due to the existing disease process. Because our child was small, debilitated, with poor cardiopulmonary reserve, OLV was unnecessary, and without any complications. VATS is performed in the upright and lateral decubitus positions, which cause mismatch in ventilation to perfusion ratio (V/Q) after general anesthesia. The V/Q mismatch is more in smaller children, especially in the lateral decubitus position, general anesthesia, neuromuscular blockade, and mechanical ventilation further increases this V/Q mismatch and make the child more prone.
to develop atelectasis. High oxygen consumption makes children more prone to rapid and profound desaturation during thoracic surgery. A comprehensive understanding of physiology of Glenn’s shunt and implications of the proposed surgical procedure (VATS) is necessary to plan the anesthetic agents, cardiovascular drugs, ventilation strategies, and other perioperative factors. Anesthetic goals include maintaining adequate preload, preserving sinus rhythm, ventricular contractility and filling, low pulmonary vascular resistance (PVR), and pulmonary blood flow, blunting the stress response to surgery and after load reduction. We placed arterial line in posterior tibial artery to monitor beat to beat BP and central line in femoral vein (internal jugular/subclavian venous cannulation is avoided in view of Glenn shunt). All the factors that could increase PVR or pulmonary artery pressure (hypoxia, hypercarbia, acidosis, hyperinflation of lungs, atelectasis, sympathetic stimulation, etc.) were avoided to maintain adequate pulmonary blood flow. We omitted nitrous oxide owing to VATS surgery, large atrial septal defect and ventricular septal defect in our patient. As one-lung gets compressed during VATS in an already cyanosed child with borderline arterial saturation, respiratory compromise is another concern; ventilator strategies included the provision of high tidal volume ventilation and a prolonged expiratory phase with low mean airway pressure simultaneously taking care not to cause hypercarbia. Adequate postoperative analgesia by means of intercostal nerve blockade and IV fentanyl facilitated improved respiratory effort, increases patient comfort, and decreased potential postoperative complications. Since our patient had intracardiac shunt, so all IV injections were given with utmost care to avoid inadvertent paradoxical embolism.

Fluid administration during thoracoscopic surgery should be done judiciously because excessive administration of IV fluids can cause increased shunting and subsequently lead to pulmonary edema of the dependent lung, particularly during prolonged surgery.

**Conclusion**

A comprehensive understanding of physiology of Glenn shunt and its implications on surgical procedures like VATS is necessary for successful anesthesia management.

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**Conflicts of interest**

There are no conflicts of interest.

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