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Comprehensive Anaesthetic Approach for Paediatric Atrial Septal Defects Closure: A Case Report on One-Lung Ventilation and Epidural Analgesia

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ABSTRACT

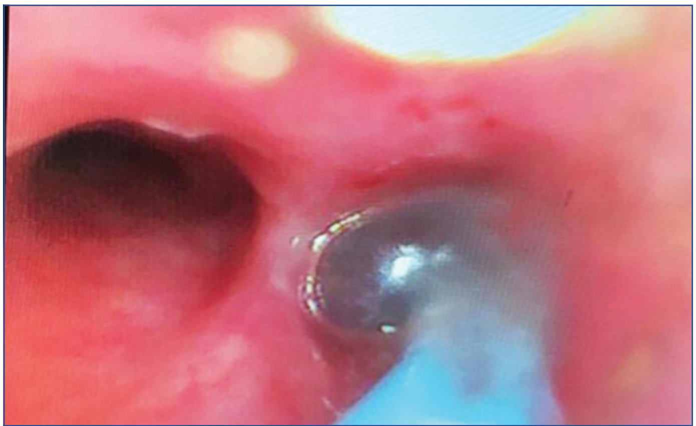
Atrial Septal Defects (ASD) is among the most frequent congenital heart defects, commonly seen in children. Such defects also carry risks like pulmonary hypertension, arrhythmias, and failure on the right-side of the heart that require surgical intervention. Though the most prominent conventional procedure used was open-heart surgery, ASD closure through minimal invasive techniques is gradually favoured in recent times. The benefits include shorter recovery times, smaller incisions, and less complications. This is a case report on the anaesthetic management of a nine-year-old child who underwent minimally invasive closure of an ASD. The child had a large ASD, with signs and symptoms such as recurrent respiratory infections and intolerance to exercise. Management strategy for anaesthesia comprised One-Lung Ventilation (OLV) modality, using embolectomy catheter followed by ultrasound guided techniques for vascular access, and epidural analgesia. These techniques provided control over the perioperative period, and promoted quick recovery after the procedure.

Keywords: Fogarty catheters, Interventional cardiology, Pulmonary hypertension, Surgical closure

CASE REPORT

A nine-year-old girl weighing 25 kg presented to the cardiology outpatient department with a history of recurrent respiratory infections and exercise intolerance, associated with chest pain for 15 days. She had easy fatiguability, and limited physical activity. Physical examination revealed a fixed split S2 and soft ejection systolic murmur without signs of heart failure. The patient had stable vital signs with a pulse rate of 98 beats/min, respiratory rate of 20 breaths per min, and oxygen saturation 98% on room air. Chest X-ray demonstrated mild cardiomegaly with enlargement of the right atrium and pulmonary plethora. Electrocardiogram (ECG) demonstrated right axis deviation with evidence of right ventricular hypertrophy. Transthoracic echocardiography showed a large secundum ASD of 30 mm in diameter, with significant left-to-right shunting, dilatation of the right atrium and right ventricle, but no signs of pulmonary hypertension. After discussion with the parents, it was decided to do a minimally invasive ASD closure.

The surgical plan, risks, and recovery were discussed with the family, and informed consent was obtained. The patient arrived in the Operating Room (OR) after adhering to paediatric fasting guidelines. Standard ASA monitors were attached, and a 20 G i.v. cannula was placed. A crystalloid bolus was given to optimise intravascular volume before induction. Anaesthesia was induced with midazolam (0.05 mg/kg) for sedation, fentanyl (2 mcg/kg) for analgesia, propofol (2 mg/kg) for rapid onset, and vecuronium (0.1 mg/kg) for muscle relaxation. A 5.5 mm cuffed endotracheal tube was placed, confirmed by auscultation, chest rise, and capnography. Auscultation on both sides and continuous capnography confirmed proper placement of the tube. Isolation of the lung was necessary to optimise the surgical field and avoid intraoperative pulmonary interference. Flexible fiberoptic bronchoscopy was placed through the endotracheal tube and a 5 size Fogarty catheter [Table/Fig-1] was introduced orally and under direct laryngoscopy by the side of the endotracheal tube after deflating the cuff. Once the catheter was seen emerging beyond the tip of the endotracheal tube, it was selectively introduced into the right main bronchus, thereby isolating the right lung and selectively ventilating the left lung. Fogarty catheter placement was confirmed through clinical and instrumental methods. Auscultation showed decreased right and preserved left breath sounds, while visual assessment revealed predominant left chest rise. Continuous capnography verified adequate left lung ventilation. The catheter was secured and monitored to prevent displacement. Ventilator settings were adjusted for optimal OLV. Lung protective strategy was used for ventilating the left lung with tidal volume 4-5 mL/kg, Positive-End Expiratory Pressure (PEEP) of 5 cm H2O and maintaining plateau pressure less than 30 cm of H2O. Fraction of Inspired Oxygen (FiO2) was adjusted to maintain Oxygen Saturation (SpO_2) more than 92% during one lung ventilation.



[Table/Fig-1]: Fogarty catheter seen in the right bronchus.

Positioned left lateral, a 20 G thoracic epidural was placed at T5-T6 using the loss of resistance technique and 0.5 mL/kg Bupivacaine injected in incremental dose. Continuous epidural infusion (0.125% bupivacaine, 0.2 mL/kg/hour) ensured analgesia and haemodynamic stability.

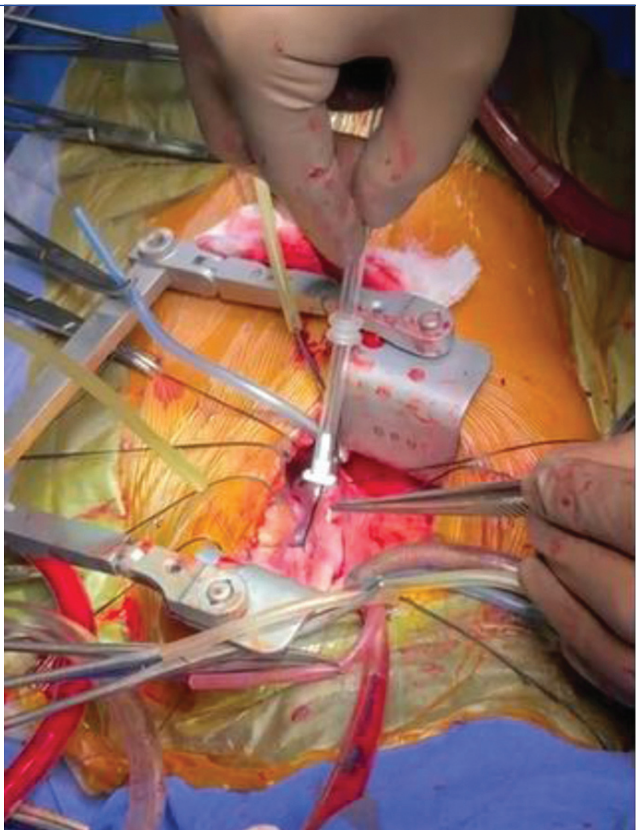
Following this, the patient had a triple lumen Central Venous Catheter (CVC) and an arterial line inserted under ultrasound guidance in the interest of precision and the minimisation of complications. 5.5 Fr.

CVC was placed into the right internal jugular vein. Ultrasound was used in visualising the vessel and confirming placement correctly to minimise the risks of arterial puncture or any other complications such as pneumothorax. Similarly, a 22 G arterial line was placed in the radial artery under ultrasound guidance, for continuous monitoring of blood pressure and arterial blood gas sampling. Due to the propensity for rapid changes during surgery, such monitoring had to be very accurate as changes in blood pressure could significantly affect circulation. The patient was given bolus of crystalloids of normal saline to establish a baseline volume status prior to starting the procedure. All fluids given during the procedure were governed by needs assessed and monitored by determining Central Venous Pressure (CVP), urine output, and clinical status.

Anaesthesia was maintained with vecuronium, sevoflurane, oxygen, and air.

Inotropic support maintained haemodynamic stability. Dopamine (3 mcg/kg/min) preserved vascular resistance and contractility, milrinone (0.5 mcg/kg/min) enhanced cardiac output, and noradrenaline (0.05 mcg/kg/min) stabilised blood pressure. Balanced fluids, including crystalloids and albumin, managed volume and blood loss. ASD closure was performed via a right thoracotomy, avoiding sternotomy. A small thoracotomy on the right-side of the chest was performed by the surgical team. [Video-1] attached to this file shows the preparation for cannulation of the patient to maintain cardiopulmonary bypass necessary for the procedures in minimal invasive cardiac surgery.

A 30 mm ASD was closed with a pericardial patch during 97 minutes of Cardiopulmonary Bypass (CPB) [Table/Fig-2]. After closure, CPB was weaned off, haemostasis achieved, and the patient extubated into comfortable, spontaneous respiration. The patient was then transferred to the Paediatric Intensive Care Unit (PICU) for postoperative care.



[Table/Fig-2]: Intraoperative image of ASD closure under cardiopulmonary bypass with retraction and cannulation in place.

The patient received high-flow nasal cannula oxygen, and gradually weaned off after stabilisation. Postoperative analgesia was adequately given through epidural. Haemodynamics, fluid balance, and drain output were closely monitored. Recovery was uneventful, with no oedema or heart failure. The patient was discharged in stable condition on Postoperative Day (POD) 5.

DISCUSSION

The ASD is a common congenital heart condition that creates abnormal communication between the atria. While most ASDs are asymptomatic and do not require surgery, some result in left-to-right shunting, pulmonary overload, and right heart enlargement [1]. If left untreated, large ASDs can lead to complications such as embolism, arrhythmias, pulmonary hypertension, and heart failure, often necessitating closure. Minimally invasive techniques have largely replaced open-heart surgery, providing benefits like smaller incisions, reduced blood loss, faster recovery, and fewer complications [2]. Though minimally invasive ASD closure is the gold standard for most children, it presents challenges for paediatric anaesthesiologists, including airway management, ventilation strategies, haemodynamic stability, and pain control [3]. This case report details the anaesthetic management of a nine-year-old, 25 kg female. The anaesthetic management involved OLV and thoracic epidural analgesia for pain relief.

Anaesthetic management for paediatric minimally invasive ASD closure is tailored for optimal outcomes, often using OLV and thoracic epidural analgesia to ensure stability, pain control, and minimal complications.

The standard surgical incision for the repair of an ASD is the medial sternotomy. Minimally invasive ASD repair involving a right anterolateral mini thoracotomy is a rapidly expanding field of cardiac surgery. Minimally invasive surgery offers numerous benefits including less pain, smaller scar faster recovery rate, reduced blood requirement and reduced hospital stay [4].

OLV is the key in thoracic surgery, allowing lung isolation and deflation. In ASD closure, OLV redistributes blood flow, reducing pulmonary complications. It optimises oxygenation, prevents hypoxia, and maintains oxygen saturation in patients with right heart enlargement and increased pulmonary flow [5]. Selective lung oxygenation enhances safety by addressing atelectasis or hypoventilation from the non-ventilated lung, common OLV complications in children [6].

Thoracic epidural analgesia offers targeted pain relief with minimal systemic effects. It blocks pain from the chest wall, heart, and diaphragm, benefiting paediatric patients who are sensitive to opioids and prone to respiratory depression and sedation [7]. Thoracic epidural analgesia reduces systemic analgesic needs, maintains pain control, and stabilises haemodynamics. It promotes early mobilisation, lowering the risk of deep vein thrombosis and respiratory complications [8].

Ultrasound-guided vascular access improves the safety of central venous and arterial line placements in paediatric patients, ensuring haemodynamic monitoring, adequate fluid resuscitation, and blood gas analysis during surgery [9]. Paediatric cannulation risks include arterial puncture, pneumothorax, and haematoma due to small vessels. Real-time ultrasound visualisation improves accuracy, safety, and reduces complications [10].

These anaesthetic techniques address paediatric ASD closure challenges. OLV enhances the surgical field and oxygenation, thoracic epidural ensures pain relief and stability, and ultrasound-guided access enables safe monitoring. Together, they improve intraoperative conditions and postoperative recovery for better outcomes.

Different technique for introduction of Fogarty catheter is mentioned but we used a novel technique of introducing the catheter by slipping it by the side of endotracheal tube and then positioning it into the desired bronchus under guidance of fiberoptic bronchoscopy.

Lung isolation and OLV is highly challenging for paediatric patient as double lumen tube is not available for that age. Various techniques like endobronchial intubation of single lumen endotracheal tube, wire guided endobroncheal Arndt blocker and Univent tubes can be used as Bronchial Blocker (BB) in children. Fogarty catheter has been used as BB in paediatric age group [11].

CONCLUSION(S)

The standard surgical incision for the repair of an ASD is the median sternotomy. Minimally invasive ASD repair involving a right anterolateral mini thoracotomy is a rapidly expanding field of cardiac surgery. Minimally invasive surgery offers numerous benefits including less pain, smaller scar, faster recovery rate, reduced blood requirement and reduced hospital stay. Paediatric patient with ASD closure requires tailored anaesthesia. The anaesthetic team addresses age, size, and heart condition using OLV, ultrasound-guided line placement, and epidural analgesia for smooth surgery, minimal complications, and fast recovery. Careful planning and good team work ensures success in paediatric cardiac surgery.

REFERENCES

[1] Le Gloan L, Legendre A, Iserin L, Ladouceur M. Pathophysiology and natural history of atrial septal defect. J Thorac Dis. 2018;10(S24):2854-63.

[2] Nashat H, Montanaro C, Li W, Kempny A, Wort SJ, Dimopoulos K, et al. Atrial septal defects and pulmonary arterial hypertension. J Thorac Dis. 2018;10(S24):2953-65.

[3] Hardman G, Zacharias J. Minimal-access atrial septal defect (ASD) closure. J Cardiovasc Dev Dis. 2023;10(5):206.

[4] Hardman G, Zacharias J, Ali J. Minimal-Access Atrial Septal Defect (ASD) closure. J Cardiovasc Dev Dis. 2023;10(5):206.

[5] Grande B, Ganter MT. What is the best strategy for one-lung ventilation during thoracic surgery? J Thorac Dis. 2018;10(12):6404-06.

[6] Bussières JS, Marques E. Atelectasis in one lung ventilation: The good, the bad, and the ugly: A narrative review. Curr Chall Thorac Surg. 2023;5:38.

[7] Fernandes RM, Pontes JPJ, Rezende Borges CE, De Brito Neto DR, Pereira ADJ, Carvalho VP, et al. Multimodal analgesia strategies for cardiac surgery: A literature review. Hearts. 2024;5(3):349-64.

[8] Freise H, Van Aken HK. Risks and benefits of thoracic epidural anaesthesia. Br J Anaesth. 2011;107(6):859-68.

[9] Ibrahim AA, Allam AR, Amin AM, Rakab MS, Alhadeethi A, Hageen AW, et al. Ultrasound-guided versus palpation-guided techniques to achieve vascular access in children undergoing cardiac surgery: A systematic review and meta-analysis of randomized controlled trials. Pediatr Cardiol. 2024.

[10] Jijeh AMZ, Shaath G, Kabbani MS, Elbarbary M, Ismail S. Ultrasound guided vascular access in pediatric cardiac critical care. J Saudi Heart Assoc. 2014;26(4):199-203.

[11] Behera BK, Misra S, Mohanty MK, Tripathy BB. Use of Fogarty catheter as bronchial blocker for lung isolation in children undergoing thoracic surgery: A single centre experience of 15 cases. Ann Card Anaesth. 2022;25(2):148-52.

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