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CASE REPORT

Core Biopsy of the Mediastinum with Video Assisted Thoracotomy Surgery Approach in Children Without One Lung Ventilation

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ABSTRACT

Video-Assisted Thoracoscopic Surgery (VATS) is a minimally invasive procedure used in the diagnosis and management of intrathoracic diseases. Patients undergoing VATS generally experience physiological alterations, including the creation of an artificial pneumothorax; therefore, anesthetic management requires a thorough understanding of these changes. This case report describes a 4-year-old child weighing 15 kg with a diagnosis of a mediastinal mass suspicious for thymoma who underwent mediastinal core biopsy via VATS without one-lung ventilation due to limited availability of appropriate equipment. Preoperatively, the patient had no respiratory symptoms, stable vital signs (oxygen saturation 97–98% on room air), and chest radiography revealed a mediastinal mass. Computed tomography (CT) scan demonstrated a superior anterior mediastinal mass. No signs of superior vena cava syndrome were identified preoperatively. The patient was classified as American Society of Anesthesiologists (ASA) physical status II, and general anesthesia was planned. Induction was performed while maintaining spontaneous ventilation. Intraoperatively, there were episodes of oxygen desaturation to 92% accompanied by an increase in end-tidal CO_2, which were managed by increasing the fraction of inspired oxygen, applying positive end-expiratory pressure (PEEP), and increasing respiratory rate through manual bag ventilation. The duration of surgery was 2 hours, with an estimated blood loss of 60 mL. Postoperatively, the patient was extubated in the operating room and admitted to the intensive care unit. Postoperative analgesia was provided using an erector spinae plane (ESP) block and intravenous paracetamol. VATS mediastinal biopsy in pediatric patients with mediastinal masses without one-lung ventilation can be performed safely; however, a clear understanding of the limitations and the extent of physiological changes is essential to ensure patient safety.

Keywords: Diagnostics, mediastinal mass, video-Assisted thoracoscopic surgery, one lung ventilation, pediatrics

INTRODUCTION

Video-Assisted Thoracoscopy Surgery (VATS) is a minimally invasive surgical procedure that is increasingly used in the diagnosis and management of various intrathoracic diseases. This procedure involves the use of a thoracoscopy equipped with a video camera to view the chest cavity and perform surgical actions through small incisions.[1] VATS offers advantages such as milder postoperative pain, a faster recovery period, and better cosmetic results compared to open thoracotomy surgery.[2]

However, patients undergoing VATS will generally experience significant physiological changes, one of which is the presence of an artificial pneumothorax. This artificial pneumothorax is necessary to provide space for surgical instruments and improve visibility during the procedure. Therefore, anesthesia management in these patients requires a deep understanding of the physiological changes that occur, including their effects on lung and cardiovascular function, as well as strategies to ensure optimal ventilation and oxygenation throughout the surgery.[3]

CASE

A four-year-old boy, weighing 15 kg with a diagnosis of a mediastinal mass suspicious for thymoma, was planned for a core biopsy procedure via VATS (Figure 1). The patient had complaints of cough, shortness of breath, fever, and a feeling of the abdomen enlarging, which had been progressive for five months prior to hospital admission. The patient had no prior history of comorbidities, surgery, or anesthesia.

Physical examination of the patient showed a moderate illness with a compos mentis state of consciousness1. Other vital signs were within normal limits (blood pressure 104/65 mmHg, pulse rate 132x/minute, respiratory rate 30–32x/minute without increased work of breathing, and oxygen saturation 97–98% on room air)2. Other physical examinations showed no abnormalities, and no signs of superior vena cava syndrome (facial edema, hoarseness, jugular vein distension) were found, equivalent to grade zero. Laboratory testing revealed anemia

Figure 1. Clinical Presentation

(hemoglobin 9.0 g/dL), while coagulation factors, electrolytes, and renal function were within normal limits. Imaging studies using plain chest X-ray showed a homogenous opacity with sharp but irregular borders in the paratracheal to the right perihilar area, suggestive of a mediastinal mass (Figure 2); meanwhile, a thoracic CT scan showed multiple inhomogeneous solid masses enveloping the ascending aorta and pushing the trachea to the right, suggestive of lymphoma (Figure 3).

The patient's anesthesia risk was assessed according to the American Society of Anesthesiologists (ASA) Physical Status as ASA 2 (a patient with a controlled mild systemic disease), and the procedure was planned under general anesthesia.Preoperative preparation included informed consent regarding the surgical procedure and anesthesia risks; the patient fasted for 6 hours (solid food), while clear fluids were permitted until 2 hours preoperatively. Intravenous (IV) access was established, and IV

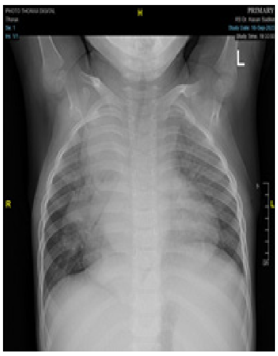

Figure 2 (left). Plain AP Chest X-Ray; Figure 3 (right). Chest CT Scan with Contrast

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maintenance fluid was provided with Ringer's Lactate at 60cc/hour. The operating room was prepared for a pediatric patient in the left lateral decubitus position, and intraoperative monitoring was set up for electrocardiography (ECG), non-invasive blood pressure (NIBP), O_2 saturation, and end-tidal CO_2. Postoperative care was planned for the intensive care unit.

Intraoperative management for general anesthesia involved preoxygenation with 100% O_2 via face mask, followed by the administration of volatile sevoflurane at 8 vol%, which was titrated down to 2–3 vol% once the patient was asleep. The patient was given 30 mcg of IV fentanyl without the use of muscle relaxant. Intubation was performed once an adequate depth of anesthesia was reached using a direct laryngoscope and a size 4.5 non-kinking endotracheal tube. After intubation, the depth of the endotracheal tube was confirmed by auscultation showing symmetrical lung fields and was then secured. Intraoral packing was placed, the eyes were taped closed, and the patient was ventilated using a Jackson-Reese circuit with manual ventilation at 12–20 breaths per minute. Maintenance anesthesia consisted of sevoflurane 2–3 vol% in an oxygen-air mixture with a 50% inspired oxygen fraction (FiO_2) targeting an oxygen saturation of 95% or above, normocapnia, and intermittent IV fentanyl. Intraoperatively, the patient was positioned in the left lateral decubitus position.

The duration of the surgery was two hours, with 60 cc of bleeding and the administration of 400 cc of Ringer's Lactate crystalloid fluid8. No shock phase occurred during the procedure; however, there was a desaturation phase where oxygen saturation dropped to 89%, accompanied by an increase in $EtCO_2$ up to 49 mmHg at the 10th minute when the right intrathoracic cavity was filled with CO_2 gas. The desaturation was managed by increasing the FiO_2 to 80% and increasing manual ventilation with the Jackson-Reese circuit. The FiO_2 was successfully reduced during the procedure at the 35th minute to 60% and maintained until the end of the procedure (Figure 4). Postoperatively, the patient was extubated in the operating room via awake extubation. The patient was monitored in the post-anesthesia recovery room and then admitted to the intensive care unit. Pain management was performed using an erector spinae block (aided by ultrasound and 0.2% bupivacaine local anesthetic, totaling 5 cc or 0.3 cc/kg) and IV paracetamol 200 mg every 6 hours.

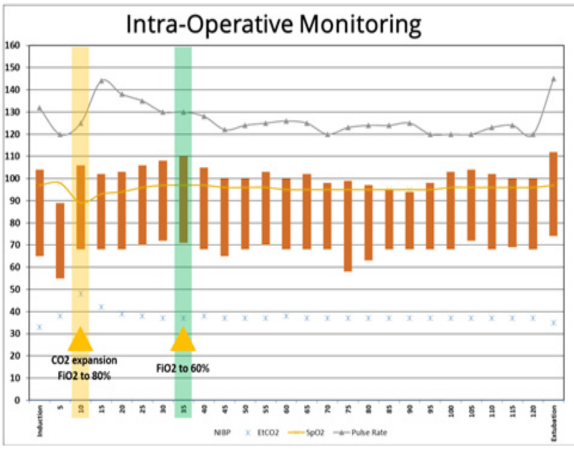

Figure 4. Intraoperative Monitoring Chart

DISCUSSION

VATS is a minimally invasive surgical technique that is increasingly popular due to its various advantages over conventional thoracotomy. One of the primary advantages of VATS is minimal bleeding, which helps reduce the risk of bleeding complications during and after surgery. Additionally, patients undergoing VATS generally report lower postoperative pain scores compared to those undergoing open thoracotomy, which means their recovery period is typically faster and less painful.[2]

In the performance of VATS, the patient's chest cavity is filled with carbon dioxide (CO_2) gas. Filling the chest cavity with CO_2 serves several important purposes, namely creating a mass effect that helps push the organs around the surgical area so that the surgical field becomes clearer and more easily accessible. This better visualization is crucial for the success of the procedure, as it allows the surgeon to clearly see the structures that need to be operated on and avoid damage to surrounding tissues. The CO_2 pressure used in VATS generally ranges between 5–6 mmHg.[1] This pressure is considered sufficient to create the necessary mass effect without posing a risk of serious complications. However, the use of CO_2 and the resulting pressure must be closely monitored to ensure that adverse physiological changes do not occur in the patient.[3,4]

Monitoring during the VATS procedure is very important, especially for detecting signs of mediastinal shift. Mediastinal shift can cause serious symptoms such as hypotension (low blood pressure) and bradycardia (decreased heart rate). If these signs appear, immediate decompression actions must be taken to prevent further complications and ensure the stability of the patient's condition.[5,6]

In some cases, One-Lung Ventilation (OLV) and the use of a Double Lumen Tube (DLT) may not be possible. In this specific case, this was due to the limited availability of equipment that can be used for the pediatric population. When OLV or DLT is not utilized, anesthesia and ventilation strategies must be adjusted to the specific needs of each patient to ensure they continue to receive adequate oxygenation, ventilation, and hemodynamic stability during the procedure.[7]

The analysis of this case includes potential intraoperative problems such as desaturation (in this case, desaturation occurred due to the filling of the chest cavity resulting from the mass effect of the artificial pneumothorax and lung retraction by the operator's instruments), which was managed by providing positive end-expiratory pressure (PEEP) or increasing the fraction of inspired oxygen. Endotracheal tube migration can also occur because the patient's position is changed from supine to left lateral decubitus. Changes in lung dynamics due to position changes also affect hemodynamics, ventilation function, and lung oxygenation, specifically the occurrence of dependent and independent lung regions (depending on position).

In this case, the upper lung after positioning had the intrathoracic cavity filled with air to create an artificial pneumothorax, thereby interfering with ventilation and oxygenation functions. In this case, hypercapnia also occurred, which was managed by the anesthesiologist increasing manual ventilation. Potential problems that may arise also include acute perioperative superior vena cava syndrome due to the compression of the mediastinal mass against important vascular structures (vena cava), which often occurs due to the use of muscle relaxants in patients with clear clinical signs of superior vena cava syndrome. In this case, muscle relaxants were not used during the procedure, and no signs of superior vena cava syndrome were found in the patient during the preoperative period. Mediastinal shift also has the potential to occur during the procedure, characterized by sudden hypotension and bradycardia due to high intrathoracic pressure shifting the mediastinum and vital organs, especially vascular ones. In this case, a mediastinal shift did not occur, but if such signs are found, communication with the operator is vital because intrathoracic pressure must be immediately returned to the patient's physiological state, and a change in position back to supine may be required until hemodynamics stabilize.

Another potential problem that can occur is the conversion of the VATS procedure to an open (conventional) thoracotomy, where this change significantly affects the management carried out in the intraoperative and postoperative periods. In the postoperative period, good monitoring is also required to detect air leaks, pneumothorax, and bleeding, as well as to manage high postoperative pain.1 In this case, pain was managed with an erector spinae plane block using 0.2% bupivacaine local anesthetic at 5cc, equivalent to 0.3cc/kg. Several literature sources mention the reference dose for volume during such blockade procedures is 0.3–0.4cc/kg, and it is not recommended to use a volume exceeding 0.4cc/kg. The blockade was performed postoperatively before extubation and with ultrasound guidance to increase success and safety during the procedure.[8]

CONCLUSION

Anesthetic management for VATS procedures in pediatric patients without the use of one-lung ventilation is still feasible and sufficiently safe in certain patients, where a good understanding of physiological changes, the VATS procedure, and effective communication between the anesthesiologist and the operator are required for optimal patient outcomes.

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