# CHALLENGES IN MANAGEMENT VENTILATION PEDIATRIC PATIENT WITH ANTEROSUPERIOR MEDIASTINAL TUMOR : A CASE REPORT

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## ABSTRAK

Tumor mediastinum, khususnya yang terletak di kompartemen anterior dan superior, memiliki tantangan besar untuk prosedur anestesi. Keganasan ini merupakan kondisi patologis langka yang dapat ditemukan pada populasi anak-anak, yang juga dapat meningkatkan risiko komplikasi kardiorespirasi karena kemungkinan obstruksi jalan napas. Selain itu, upaya untuk mempertahankan patensi jalan napas melalui ventilasi satu paru juga mengakibatkan ketidaksesuaian ventilasi/perfusi jika tidak dilakukan dengan hati-hati. Makalah kami membahas kasus laki-laki berusia 12 tahun dengan keluhan awal kesulitan bernapas progresif sekitar dua bulan sebelum masuk rumah sakit dan merasa lebih lega jika berbaring di sisi kanannya. Pasien didiagnosis dengan tumor mediastinum anterosuperior yang menjalani torakotomi clamshell. Selama prosedur sedasi, pasien kami mengalami desaturasi oksigen progresif, di mana pasien mengalami ventilasi manajemen yang sulit setelah intubasi. Tindakan segera diambil untuk memulihkan pasien ke keadaan fisiologis termasuk manipulasi posisi untuk mengembalikan kecocokan ventilasi/perfusi (V/P). Kami mengubah posisi pasien ke posisi dekubital lateral kiri yang mendukung ventilasi yang lebih baik untuk mengoreksi ketidaksesuaian V/P. Saturasi tetap normal setelah kami menempatkan pasien dalam posisi terlentang, yang mungkin didukung oleh kemampuan paru-paru dependen untuk mendukung kebutuhan oksigenasi dan distribusi transpulmonal yang seimbang selama torakotomi. Kami membahas mekanisme singkat yang mendasari kondisi tersebut untuk digunakan sebagai referensi kasus serupa di masa mendatang.

**Kata kunci :** manajemen ventilasi, pediatri, thorakotomi *clamshell*, tumor mediastinal

## *ABSTRACT*

*Mediastinal tumor, especially ones located in the anterior and superior compartments, possesses great challenge for anesthetics procedures. This malignancy is a rare pathological condition which may be found in pediatric population, which also may increase the risk of cardiorespiratory complications due to possible airway obstruction. Additionally, the effort to maintain the airway patency through one-lung ventilation also results in ventilation/perfusion mismatching if not done carefully. Our paper discusses a case of 12-year old male with initial complained of progressive breathing difficulty approximately two months before current admission, reported relieved breathing when he laid down on his right side. Our patient was diagnosed with with anterosuperior mediastinal tumor underwent clamshell thoracotomy. During the sedation procedure, our patient experienced progressive oxygen desaturation, where our patient faced difficult management ventilation after intubation. Immediate action was taken to recover the patient into physiological state including manipulation of position to restore the ventilation/perfusion (V/P) match. We repositioned our patient to left lateral decubital position which supported better ventilation to correct the V/P mismatching. The saturation remained normal once we put the patient in supine position, which might be supported by the ability of dependent lung to support oxygenation need and balanced transpulmonary distribution during thoracotomy. We explore brief mechanisms underlying the condition to be used as future reference of similar cases.*

***Keywords** : mediastinal tumor, pediatric, ventilation management, clamshell thoracotomy*

## INTRODUCTION

Malignancy of the mediastinum is a rare case in pediatric surgical oncology. This cancer may develop from the anatomical structures inside the mediastinum, or that transverse through

the mediastinum itself, or is a product of metastases from other adjacent/far organs. Studies found that the incidence found mainly in adults age 30 to 50 years old, although cases in pediatric are also not uncommon (Jilani, Killeen and Siddiqui, 2024). Mediastinal tumor is the most prevalent thoracic masses found in children, especially because children have unique physiological conditions and anatomical structures compared to adult, such as the presence of active thyme, where one of the most common causes of mediastinal malignancies is thymoma (Çinar *et al.*, 2023). Other than that, tumors that may be found are lymphoma, germ cell tumors, and neuroblastoma (Chen *et al.*, 2019).

The location where the masses manifest may also vary, from the superior, anterior, middle, to posterior comparments of the mediastinum. Among the three of them, anterior masses, limited within the sternum and pericardium, possess greater challenge compared to the other three locations, as it may compromise with the respiratory and cardiac function, therefore complicating the anesthetic process before the surgery takes place (Ku, 2011; Chawla *et al.*, 2013). Anterior mass has greater risk of airway obstruction, therefore extra attention towards the anesthetic management, especially in addressing difficult airway, is required in pediatric cases, considering the different respiratory physiology they have compared to adult populations. Additionally, when the mass was found in large size, the operator may choose to excise the tumor with clamshell thoracotomy. Clamshell thoracotomy, which is also known as bilateral anterolateral thoracotomy, is a surgical technique where the incision covers both the right and left hemithoraxes. This method is particularly chosen when the greater access or exposure needed by the operator where heart, mediastinum, and lungs are visible. In addition, this technique allow access to the hilar structures and dissection of the anterior part of tumor located in the thorax (Odell, Macke and O'Shea, 2011; Subbanna *et al.*, 2013; Toda *et al.*, 2017).

The practice itself has also been conducted in another pediatric case with large anterior mediastinal teratoma, where the use of clamshell provided satisfactory field and was safe to be conducted (Adhyasta Nata Prawira Subianto and Maz Isa Ansyori Arsatt, 2022). Yet, the use of clamshell thoracotomy also e adds concerns to the anesthetic procedure, since the induction may higher the risk of awake patient's compensatory mechanisms loss (Brooks and Lata, 2023). Our paper is going to discuss a case of anterior mediastinal tumor in 12-year old male patient, the airway difficulties we encountered, and the management conducted before, during, and after the surgery.

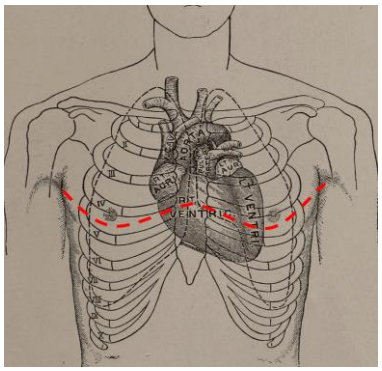

**Figure 1. Bilateral Anterolateral "Clamshell" Thoracotomy Procedure(Qasim, 2019)**

## CASE REPORT

A 12-year-old boy, 42.4 kgs was admitted to the hospital for elective clamshell thoracotomy surgery after previously diagnosed with anterosuperior mediastinal tumor. Patient previously complained of progressive difficulty of breathing 2 months before current admission, with dyspnea that got better when he laid down on his right side. Other positive

symptoms included recurrent productive cough. No significant antenatal history was found in the patient. During physical examination, we found the patient with mild protein-energy malnutrition (PEM), weakened lung sound on the left side, with Sabrasez test result of 16 seconds and negative Pemberton sign. Systolic murmur was found on the left parasternal line as high as the second intercostal space. Patient was found with edema on his extremities. Biochemical investigation showed electrolyte imbalance with hypoxemia. The mediastinal mass was confirmed with chest X-ray and CT-scan. Echocardiography result marked the presence of moderate circumferential pericardial effusion without echo sign tamponade with mild pulmonary stenosis and mild tricuspid regurgitation, while the spirometry confirmed moderate-to-severe lung restriction.

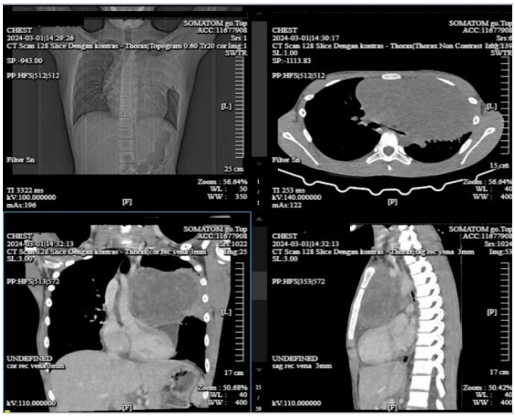

**Figure 2. Preoperative CT-Scan found heterogenous solid mass with internal necrotic component on the anterosuperior mediastinum extending to right and predominantly left hemithorax with estimated size 17.8 x 9.6 . 9.8 $cm^3$ attaching to bilateral parietal pleura. The mass caused deviation of the trachea, esophagus, and aorta to the right side, and narrowing of the left main bronchus. The imaging indicated malignant mediastinal mass on the anterosuperior compartment**

We established an intravenous (IV) access in the right hand with 22 G cannula for fluid and medications administration. Additionally, we set an artery line on the left radial artery with prior 2% lidocaine administration and Allen test. The central venous catheter (CVC) was also placed with 7 Fr catheter on the femoral vein, guided by the ultrasonography (USG) for more accurate placement. Before the operation, the patient was given several medications including 4% Lidocaine nebulization, 10 mg Dexamethasone, 10 mg Diphenhydramine, 1.5 mg Midazolam, and 10 mg Ketamine where all four drugs were given intravenously. The analgetic of choice was Fentanyl 120 mcg given intravenously, followed by induction of Dexmedetomidin 1 mcg/kg body weight for loading dose in 10 minutes which was maintained with 0.3 – 0.5 mcg/kg/hour titration. After the mask ventilation, we proceeded to intubate the patient. The Sleep Non-Apnea technique for induction was chosen for this case. Prior to intubation, our patient was positioned in right lateral decubitus (RLD), where our patient claimed for better comfort, with slight 15˚ bed elevation.

A double lumen tube (DLT) size 32 was then inserted then placed to the left bronchus using Video Laryngoscope. We confirmed the placement by comparing the sounds between the right and left lungs. However, once the tube was placed, we put the patient back to the supine position where we noticed oxygen desaturation to 74%-85%. We attempted to return the patient back to RLD but the saturation remained unchanged for the next twenty-minutes while the bagging also felt heavy to conduct. Consequently, we repositioned the patient to left lateral decubitus (LLD) and noticed massive improvement and the saturation reached 99%-100% and the bagging felt lighter compared to the previous position. When the saturation remained optimal, the patient was then put supinely again for better surgical view and the

intubation was connected to the ventilator (with PCV Pins 12, RR 14, PEEP 10, $FiO_2$ 70%). No desaturation reoccurred until the end of the surgical procedure.

Epidural analgesia access was placed on the thoracal T7 with the target tip reaching up to T5 level, aiming for the effect on dermatome T2-T5 in order to maximize our pain management. Bupivacaine 0.25% was given with a volume of 8 ml incremental dose. We maintained the anesthesia with O2:Compressed air, Sevoflurane 2 vol%. To control bleeding 1000 mg Tranexamic acid, and we administered intravenous 750 mg Paracetamol for multimodal analgesia. We used combined modality of fluids during the surgery, including 2500 ml Ringer's Lactate, 500 ml colloid, and 785 packed red cells (PRC).

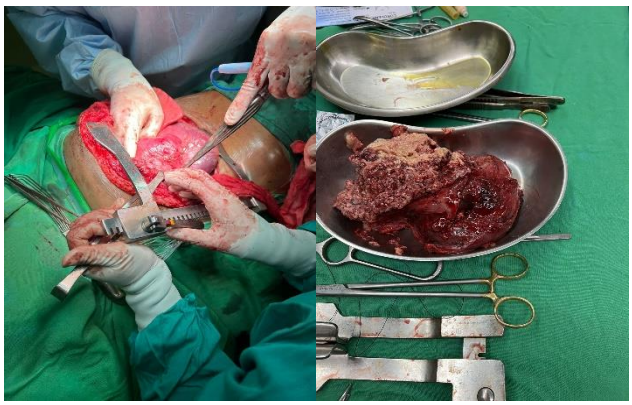

**Figure 3. A Portion Of The Anterior Mediastinal Tumor Was Successfully Resected**

All vital components including the heart rate, systolic and diastolic blood pressures, mean arterial pressure, oxygen saturation, end-tidal carbon dioxide, and electrocardiography were observed. We observed the presence of supraventricular tachycardia which we immediately converted with vagal maneuver to normal sinus rhythm. The Surgeon have found Mediastinal mass measuring 20x10x10 cm which encases the innominate vein, pericardium and superior lobe of the left lung, attached to the aorta and pulmonary artery. This mass was totally removed and lobectomy was done on the superior lobe of the left lung by the surgeon. No other adverse events happened until the end of the surgery. Post-operative medications, namely the epidural 0.0625% Bupivacaine and 8 ml 0.5 mg Morphine, intravenous 750 mg Paracetamol, and oral 400 mg Ibuprofen were prescribed. Our patient was admitted to the Intensive Care Unit (ICU) and ventilated for 1 hour before extubated. The hemodynamic status was stable and once recovered, the patient was discharged with insignificant event or complications.

## DISCUSSION

A case of anterior mediastinal mass contributes to greater anesthetic challenge, especially because of the cardiorespiratory risks. Its location may lead to compression of the airway, leading to obstruction. It may occur more prevalently in children, as they have smaller tracheal diameter which leads to increase of airway resistance. Additionally, the large size of the tumor was contributing to higher risk of greater ventilation/perfusion mismatching (Ku, 2011). The situation may also be worsened by the clamshell procedure, where the massive incision created challenges in maintaining respiration physiological function. The use of the anesthetic drugs may create loss of compensatory mechanisms, signified by shifting of mass during positional changes, decreasing patency with relaxation, and increased intrathoracic pressure accompanied by lower venous return during positive pressure ventilation (PPV) (Brooks and Lata, 2023). In our case, the patient was induced under non-sleep apnea technique to lower the chance of lung collapse and minimize relaxation of the bronchial smooth muscles, reducing obstruction to the dependent lung (Ku, 2011). The used anesthetic agent was Sevoflurane combine with

Dexmedetomidine, commonly used to maintain spontaneous breathing (Karzai and Schwarzkopf, 2009; Lohser and Ishikawa, 2011; Wijaya Ramlan, Ang and Peddyandhari, 2020). Additionally, the one-lung ventilation used in our case to improve exposure of the surgical field, also came with challenges to maintain proper lung compliance and oxygenation. Yet, these considerations were not enough to maintain the ventilation and perfusion balance.

The particular thing that this study would like to highlight is how manipulating patient's position aided to maintain appropriate ventilation and perfusion to the dependent lung. Our patient was initially intubated in RLD, which was the most convenient position during the awake state. This was supported by the evidence of predominantly left-located mass in the superior, precisely in the anterosuperior compartment of the mediastinum, where the right lung would receive better perfusion due to gravitational force and better ventilation due to more efficient hemidiaphragm contraction, as well as to be more compliant. As the result of anesthesia induction, the lower lung became less compliant hence our patient showed desaturation in the beginning of the intubation. Early supination for the patient was not well tolerated in the early phase, possibly because the ventilation favored the dependent right lung with equal perfusion to both lungs, hence aggravating the ventilation/perfusion mismatching. The hypoxia also occurred because the lack of gravity redistribution created larger shunt to the independent lung (Lohser and Ishikawa, 2011; Butterworth, Mackey and Wasnick, 2022). Our decision to reposition the patient to LLD supported better ventilation to the right lung, compromising with the ventilation/perfusion mismatching.

The special situation, however, was the exact mechanism to why the saturation eventually remained stable in supine position. We hypothesized that the supine position provided equal ventilation and perfusion where the dependent lung was capable to support the oxygenation need. Once the thorax was opened in the operation, it also relieved the dependent lung from the burden of mediastinal compression and allowing balanced transpulmonary distribution of gas to happen. Additionally, recent study suggested the higher stress imposed to the lung under OLV and higher lung instability (defined as end-expiratory $P_L$<2.9 $cmH_2O$) to lateral position compared to the supine (Wittenstein) (Wittenstein *et al.*, 2023). Therefore, in case of major thoracal surgery requiring supine position, especially in the presence of large mass, the patient might benefit from having switching positions from one side with favorable lateral decubitus to the other after induction, before putting them supinely. It is also worth noting that the repositioning was not without risk of DLT malposition, hence reconfirming the placement is important to maximize airway access and ventilation (Pokhriyal, Tomar and Saran, 2024).

## CONCLUSION

Our discussion concluded that the challenges to maintain proper oxygenation through mechanical ventilation in case of children with large anterosuperior mediastinal mass are inevitable. However, understanding the physiology of respiration and how the gravity affects ventilation of each lung, depending on its position, may benefit the anesthesiologist to determine the best position during induction and intubation. While the position manipulation is crucial, any anesthesiologists also should always consider the preoperative condition of the patients as well as the use of any instruments and drugs to maximize the oxygenation, perfusion, and ventilation that may relieve or aggravate the surgical preparations.

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