Title: The ‘CAN INTUBATE CANNOT VENTILATE’ Scenario in a patient with an undiagnosed anterior mediastinal mass

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OBJECTIVES:
After preparing for and discussing this case, PBLD participants will be able to:
1. Formulate a plan for the acute management of a compromised airway in a ‘can intubate cannot ventilate’ scenario.
2. Discuss the importance of pre-operative assessment in a patient with suspected mediastinal mass
3. Apply the principles of pathophysiology for the management of a patient with an anterior mediastinal mass
4. Develop a plan for the safe anesthetic management of a patient with an undiagnosed or an established diagnosis of an anterior mediastinal mass

Case History:
A 15 yr old male patient with suspected lymphoma is scheduled for cervical lymph node biopsy, bone marrow aspiration and mediport insertion. You see him on the day of surgery, preoperatively. He is an ex-smoker having stopped just 6 months ago. The patient denies any respiratory symptoms. He is able to lay supine. Examination reveals a Mallampati grade 1 view, adequate mouth opening and a normal neck. The remainder of the exam was normal.

Questions: Is there anything else in the preoperative examination and preparation that would have implications on the anesthesia? What investigations would you like to review? Why? Do we need more information?

Case history and physical exam:
His chest radiograph and CT scan were done at an outside hospital. They were reviewed by the surgeon, radiologist and hemato-oncologist and were deemed as ‘not significant’ for airway compromise. These examinations are not available to the anesthesiologists for review pre-operatively.

Question: Is this information sufficient? What is your anesthetic plan?

Case progression:
Intravenous access is commenced in the preoperative holding area. Midazolam 2mg is then administered intravenously and the patient transferred to the operating room on the stretcher in the supine position.

Question: Is his ability to lay supine important in the history? Any comments?

In the operating room, anesthesia was induced following the application of standard monitors and preoxygenation for 5 minutes. Fentanyl 100 mcg and propofol 200 mg are
administered intravenously. After judging the ability to mask ventilate, rocuronium 50 mg, intravenously, is administered. Adequate mask ventilation with 100% FiO₂ is continued until adequate muscle relaxation was established.

**Questions:** Is endotracheal intubation necessary in this case? If so why? Why not LMA? Is rocuronium a reasonable choice for muscle relaxation in this case? Would you have used succinylcholine? If so, why?

An attempt is made to intubate the patient with a size 7cuffed oral endotracheal tube (ETT). No visible chest rise, audible breath sounds on auscultation or an EtCO₂ trace are noted.

**Questions:** What is your reaction to this? Could it be an esophageal intubation? Why? Why not? What is the value of capnography in confirming correct placement of the endotracheal tube? What are other ways to confirm correct endotracheal placement?

The ETT has now been removed and an attempt is made to resume mask ventilation with an oropharyngeal airway with FiO₂ 100%. There is failure of mask ventilation and decrease in SpO₂ to 95%.

**Questions:** What would you do in this situation? You try various maneuveres to reposition the patient, also an oropharyngeal airway but mask ventilation still fails. What would you do at this point? What are the causes of failure of mask ventilation in a patient who was previously easy to mask ventilate?

The anesthesiologist decides to do a check laryngoscopy. A check laryngoscopy revealed a Cormack and Lehane grade 1 view. The trachea is easily intubated for the second time now and transglottic placement confirmed during direct laryngoscopy. However, no visible chest rise, audible breath sounds on auscultation or an EtCO₂ trace were noted.

**Question:** Would you call this a “CAN INTUBATE CANNOT VENTILATE” scenario? What are the likely causes? What is the differential diagnosis? What would be your further management?

A STAT call for all available help in the operating room is made by the attending anesthesiologist. There is a palpable pulse. The patient is administered epinephrine intravenously.

**Question:** What is the rationale for using epinephrine? How much would you give, what dosage?

A presumptive diagnosis of anterior mediastinal mass as a cause is considered.

**Question:** What are the maneuvers that can be performed at this point to establish patency of the airway? In what sequence would you perform these maneuvers?

An attempt to advance the ETT further to stent the trachea is made at this point. However, there is resistance to advancement. Manual ventilation with high airway pressure fails and SpO₂ worsens to 35%. The patient is repositioned to lateral and then prone position. The rigid bronchoscopy equipment is being set up in the room.
In the prone position, ventilation is possible with breath sounds on auscultation, appearance of EtCO$_2$ trace and improvement of SpO$_2$. Patient’s oxygen saturation stabilizes.

*Question*: What further investigations would be useful for further diagnosis and management?

A chest radiograph reveals mediastinal widening. Attempts to pass a 14 Fr suction catheter meets with some resistance. Fiberoptic bronchoscopy via the ETT reveals severe tracheal collapse as shown in the figure below.

![Fiberoptic Bronchoscopy Image](image_url)

*Questions*: Does a fiberoptic bronchoscopy prove useful to confirm the diagnosis in this case? How would this change your management? Would you proceed with the surgery? What is the further management of this patient?

Dexamethasone 12mg intravenously is subsequently administered. A decision to proceed with the lymph node biopsy in the prone position is made. The surgery is completed.

*Question*: Would you attempt to extubate this patient? In what position would you perform a tracheal extubation?

The patient receives reversal of the non-depolarizer muscle relaxant (neostigmine 3 mg and glycopyrrrolate 600mcg intravenously) in an attempt to awaken from anesthesia at the completion of the procedure. However, the patient desaturates rapidly.

*Question*: What is your plan for further management of this patient? What are the possible causes of desaturation noted on the pulse oximetry at this point?

**Post procedure course:**

A decision is made to transfer the patient with the endotracheal tube in situ to the pediatric intensive care unit in the prone position. Upon subsequent follow-up: Microscopic exam of the biopsy reveals a Tcell lymphoma. After 72 hrs of steroid therapy, chemotherapy and following a check fiberoptic bronchoscopy he is safely extubated in the PICU. He is found to have no neurological deficits. In conversation post extubation, he reveals that he did have symptoms of shortness of breath at night which he attributed to smoking.

*Question*: What and how would you explain to the parents regarding the course of events?
PROBLEM BASED LEARNING DISCUSSION

Complete airway obstruction and cardiovascular collapse after the induction of general anesthesia are the most life threatening complications at induction of general anesthesia in a patient with an anterior mediastinal mass (1-5).

In this scenario, although the patient was investigated for mediastinal mass two weeks prior to the procedure, the results were ‘verbally’ communicated to the anesthesiologist as of ‘no significance’. It is possible that the mass increased in size in the interim and was significant enough to cause a complete airway obstruction at induction of anesthesia. An anesthesiologist may be presented with this scenario of unanticipated or anticipated airway obstruction and a high index of suspicion and rapidity of management may be life saving for the patient.

The antero-superior mediastinum is affected by malignancy in pediatric patients in greater than 1/3 of all cases of mediastinal mass (1). The most common etiologies are lymphoblastic lymphoma and Hodgkin’s disease. Other lesions that present as anterior mediastinal masses in children include malignancies of the lung or pleura, vascular malformations, neurogenic tumors, germ cell tumors and cysts.

There are three challenging problems that a patient with mediastinal mass may present:

1. Acute airway obstruction
2. Compression of the heart and pulmonary artery
3. Superior vena cava syndrome

Although the patient in this scenario presented for supraclavicular lymphnode biopsy, patients may present for excision of mediastinal tumors or biopsy needing thoracoscopy, thoracotomy or even a median sternotomy. One must always consider local anesthesia (not feasible in younger children) and reduction of mass size with steroids and radiation therapy prior to administration of a general anesthetic; although this may change tissue histologic appearance and make an accurate diagnosis much more challenging. A multidisciplinary approach with the oncologist, radiologist, surgeon and anesthesiologist is necessary in a careful decision making regarding management of a patient with an anterior mediastinal mass.

1. Acute airway obstruction:
Many patients with a mediastinal mass may present with respiratory or cardiovascular complains. A thorough history must include inquiring about dyspnea when changing positions or upon assuming the supine position. The absence of significant signs and symptoms pre-operatively however does not preclude the possibility of airway or cardiovascular collapse under anesthesia. The consults must be obtained from the pediatric, hemato-oncology, anesthesiology, radiology and the pediatric surgery team. Where feasible, a CT scan and a flow-volume loop must be done as this may help define the severity of respiratory compromise. A suggested marker for high risk of respiratory compromise after induction of general anesthesia is a tracheal cross-sectional area of less than 50% of normal. Flow-volume studies demonstrating limitation of expiratory flow may be predictive of airway collapse under anesthesia. In addition to eliciting a history of
Positional dyspnea or stridor, the preoperative workup must also include chest CT (for evidence of direct tracheal compression), and pulmonary function testing with a flow-volume loop to reveal the impact on ventilation and PEFR.

When there is suspicion of airway compromise in a patient with anterior mediastinal mass the methods of management under general anesthesia may include:

1. Maintaining spontaneous ventilation
   - Normal transpulmonary pressure gradient assists in maintaining airway patency, even if external mass compression exists; therefore, the onset of pharmacologic neuromuscular paralysis in a previously patent airway will lead to disastrous airway obstruction (9).
2. Positioning lateral or prone
3. Stenting the obstruction with an endotracheal tube, rigid bronchoscope, or even an endobronchial intubation.
4. Rescue ECMO via femoral cannulation
   - Even experienced operators will require 20-30 minutes to perform this; therefore, this should be the last resort, and not the first back-up.

The use of CPAP may help to maintain the functional residual capacity that is otherwise reduced under general anesthesia. Elevating the head of the bed also may be useful. It is thought that the loss of tone in the muscles of the chest wall with administration of neuromuscular blockade increases the risk of severe airway compromise. The use of a helium-oxygen mixture may be beneficial as its decreased density permits laminar flow in an encroached major conducting bronchi or trachea and decreases the resistance to gas flow (8).

2. Compression of the heart and pulmonary artery
   This is a life-threatening complication. There is history suggestive of extrinsic cardiac compression in the form of dyspnea and a history of syncope with valsalva maneuver. A chest CT and echocardiogram may reveal a pericardial effusion which must be drained preoperatively. Other strategies of management may include: lateral or prone positioning, maintaining venous return and cardiac output, spontaneous ventilation and stand-by cardiopulmonary bypass.

3. Superior vena cava syndrome
   The patient with superior vena cava syndrome may present with facial or upper extremity edema, venous congestion, dilated veins on the face and upper extremity, respiratory symptoms (nasal congestion, cough, orthopnea), or central nervous system effects (mental status changes, headache etc). A CT scan with contrast may be useful. Strategies of management may include lower extremity iv access, head elevation, diuretics, steroids, radiation therapy preoperatively and SVC stenting.

It must be remembered that absence of significant signs and symptoms does not preclude the possibility of circulatory or airway collapse under anesthesia (5, 6). Further, in this scenario the anesthesiologist was faced with an undiagnosed mediastinal mass but had a high index of suspicion due to the course of events at induction (5, 6, and 10). There have
been reports in literature where this situation has occurred in pediatric and adult patients. It has been suggested that institutions should have algorithms in place for the evaluation and treatment of children with mediastinal masses (7).

References: