Not Your Average Weekend Case: VATS for Anterior Mediastinal Mass (AMM) Biopsy

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Objectives:

1. Develop a plan for preoperative evaluation and preparation for a child with a large anterior mediastinal mass.
2. Understand and identify options for induction of anesthesia and potential intraoperative critical events in a patient undergoing an anterior mediastinal mass biopsy.
3. Review data using signs and symptoms, radiologic tests, and pulmonary function tests to risk stratify patients undergoing general anesthesia.
4. Discuss the available anesthetic choices for sedating children presenting for noninvasive procedures and the current use of dexmedetomidine in pediatric anesthesia.

A previously healthy 5 year old male presents to the ED with severe respiratory distress, facial fullness, and a new diagnosis of a large anterior mediastinal mass. Upom examination in the PICU, he is sitting up, obviously in respiratory distress, with RR in the 40's, nasal flaring, deep suprasternal retractions, and saturation in the low 90s on a non-rebreathing mask. CXR shows what looks like AMM, surgery resident calls you to schedule VATS for mass biopsy STAT on Saturday.

What are the boundaries of the mediastinum and what are the common mediastinal masses in the pediatric age group?
How are you going to respond to the surgery resident's request?
Is this an emergent, urgent, or completely elective procedure?
Would you proceed with anesthesia or delay it after further investigations. If yes, what other studies do you need to conduct? How will they help your anesthetic management?
Would you proceed with the case if the patient was asymptomatic?
Why do children with anterioir mediastinal tumors at diagnosis often pose significant management challenges to anesthetists?

Patient barely tolerates a CT scan, which shows a mass encasing the great vessels with significant compression of the intrathoracic trachea extending to the carina. At its most flattened level (the level of aortic arch), the anteroposterior diameter of the trachea measures 0.8 mm. The Echo shows compression of the right superior vena cava.

What is superior vena cava syndrome?
What are the symptoms and signs associated with anesthetic complications?
Is VATS the only option for biopsy? What other diagnostic modalities are available?

The surgeon wants to perform a supraclavicular lymph node biopsy in the OR using local anesthesia and under sedation, but is hesitant because of the severe symptoms.

Is there a way to alleviate these symptoms?

After discussion with various services, the decision was made to administer two doses of steroids to shrink the tumor and *then* proceed with the lymph node biopsy under sedation.

Would dexmedetomidine be an attractive choice in this scenario?
Is dexmedetomidine alone an appropriate anesthetic choice?

The results of the biopsy are inconclusive, and due to the location of the mass, an ultrasound-guided biopsy cannot be done, leaving VATS as the only option to obtain a diagnosis to proceed with the treatment.

The parents ask about the anesthesia procedure and the possible complications associated with the use of anesthesia. How are you going to respond?
How are you going to prepare the child and the OR for induction?
How will you induce the child? What anesthetic agents would you choose for induction and maintenance?
What monitors would you use?
What are the potential complications with this procedure and how would you prepare to manage them?
How would you secure the airway? Is lung isolation possible?
Would you use a muscle relaxant? What would you use for anesthetic maintenance?

After securing large bore IV access and an arterial catheter, patient was induced with fentanyl, propofol and ketamine boluses. Fiberoptic intubation was done and the lung isolated with the patient in a semi fowler's position using an armored endotracheal tube. Anesthesia was maintained with air, oxygen, ketamine, fentanyl, and propofol infusion. No neuromuscular blocker was given and spontaneous ventilation was maintained. Upon positioning the patient in the lateral decubitus position, he becomes hypotensive.

What do you think is going on?
How would you treat the hypotension?
Would you use TEE?

Hypotension resolved and the patient is stable now in the lateral decubitus position. Thirty minutes into the procedure, the patient desaturates acutely.

You suspect airway compression, what are you going to do?
Is there a role for Heliox?
What about ECMO?

DISCUSSION

Mediastinal Masses:

The mediastinum is an anatomic space bound by the sternum anteriorly, the ribs and spine postero-laterally, the thoracic inlet cranially, and the diaphragm caudally. Functionally, the mediastinum is subdivided in relation to the pericardial sack into anterior, middle, and posterior mediastinal spaces. Mediastinal masses are either neoplastic or non-neoplastic masses. Anterior Mediastinal Masses (AMM): Usually of hematological source (lymphoblastic lymphomas and Hodgkin's disease) are usually associated with high perioperative morbidity and mortality.

Anesthetic Challenges:

Children with mediastinal tumors at diagnosis often pose significant management challenges to anesthesiologists because providing anesthesia may result in dramatic respiratory and cardiovascular complications including progressive airway obstruction, loss of lung volume, superior vena cava (SVC) obstruction, and pulmonary artery or cardiac compression. All of these effects may be worsened by anesthesia due to changes in cardiorespiratory physiology, which occur with supine position, positive pressure ventilation, paralysis, and anesthesia.

Preoperative Evaluation:

Preoperative evaluation starting with history and physical examination should focus on identifying the signs and symptoms that predict perioperative risk. It is especially important to elicit a history of dyspnea, particularly if a postural component is present. Positional dyspnea or orthopnea and stridor are potentially ominous signs and may predict the degree of tracheal compression, pulmonary function abnormalities and the likelihood of complications. Cardiovascular symptoms may result from compression of the SVC, pulmonary arteries, or the heart itself. Diagnostic imaging studies like a chest CT scan is mandatory to delineate the anatomy of the mass and detects the tracheobronchial and vascular compression. Patients with more than a 50% decrease in tracheal cross-sectional area (CSA) are more likely to be symptomatic and suffer from perioperative complications, whereas a tracheal CSA of more than 50% of normal appears to be associated with a low incidence of respiratory complications. The Flow Volume Loop test is very useful when done in both upright and supine positions to detect the dynamic compression of the airway. Supine Peak Expiratory Flow Rate (PEFR) < 50% of the predicted normal is an indicator of a compressed airway. With that said, bear in mind that the severity of the patient's preoperative respiratory symptoms *may bear no relationship* to the degree of the respiratory compromise encountered during anesthesia. However, it is prudent to conclude that children with significant cardiorespiratory symptoms may be at risk for respiratory problems and should be approached with caution. Echocardiography is also done in the upright and supine positions to evaluate cardiac, superior vena cava, and pulmonary outflow compression. Patients with masses compressing the pulmonary artery may be relatively asymptomatic while awake, but may develop life-threatening hypoxemia during anesthetic induction or under mild sedation. Timing of preoperative studies may be important due to the rapid growth of certain tumors.

Knowledge of the degree of airway narrowing and vascular compression measured on imaging, careful assessment, planning, maintenance of spontaneous ventilation, and proper poisoning cannot be overemphasized in this procedure

Perioperative Considerations:

Before proceeding with any procedure in these patients, a care conference should be held with the surgeon, anesthesiologist, and the hematology oncology physician. This conference should include discussion of treatment modalities that can be employed to reduce the tumor bulk before anesthesia induction. Every effort is conducted to complete the case under local anesthesia and/or minimal sedation, if feasible. This can be done by peripheral blood analysis, pleural fluid cytology and analysis, bone marrow aspiration, open/needle biopsy of accessible extra-thoracic disease lesions (e. g., lymph nodes), and, recently, endobronchial ultrasound transbronchial needle aspiration (EBUS-TBNA).

Operative Management:

On the day of the procedure, one should be diligent with the use of sedatives. Nebulized lidocaine in the holding area may help to minimize airway reactivity during intubation. Arterial line and large bore lower extremity vascular access should be secured especially in patients with SVCS prior to induction with emphasis on the importance of adequate preload to minimize hemodynamic instability. Patients should be induced with the head elevated or in the preferred position by the patient. Every effort should be taken to maintain spontaneous ventilation under general anesthesia all the time, typically achieved with the use of inhaled anesthetics and small doses of opioids, or a combination of propofol and ketamine. Of note, dexmedetomidine and ketamine have been used successfully for sedation in non-invasive procedures to obtain percutaneous biopsies.

Airway can be managed with a laryngeal mask airway (LMA) or reinforced endotracheal tube (ETT) after achieving deep levels of anesthesia. Lung isolation and single lung ventilation is possible with the patient breathing spontaneously. The use of airway regional techniques to facilitate intubation or neuro-axial techniques to facilitate surgical anesthesia are advantageous as they decrease the GA requirement providing airway stability. Uneventful induction does not preclude later complications within the case. The ETT may lose the rigidity later and the airway can collapse by the weight of the mass. A skilled bronchoscopist should be available in the room during induction as a rigid bronchoscope can facilitate re-establishment of ventilation and oxygenation in cases of airway collapse. Median sternotomy and cardiopulmonary bypass have been recommended, but may be impractical unless bypass access is established before induction.

Patients with an AMM may develop severe hemodynamic compromise caused by compression of the heart and great vessels after induction of anesthesia, institution of positive-pressure ventilation, or supine positioning. Increased vascular compression can result in life-threatening perioperative events, and intraoperative deaths have been reported without evidence of tracheal obstruction resulting from cardiac and pulmonary vasculature compression or encasement. Although preoperative transthoracic echocardiography (TTE) has frequently been used in the past, intraoperative transesophageal echocardiography (TEE) has recently been accepted as allowing for a more detailed evaluation of the mediastinum for masses and secondary compression of vascular structures.

Extubation depends on the course of the procedure. If surgical edema or hemorrhage is suspected, the patient should be left intubated and transported to the ICU; tumor therapy should be started and extubation attempted only after demonstration of tumor regression in the following few days.

Dexmedetomidine is a highly selective alpha-2 adrenoceptor agonist with sedative, analgesic, neuroprotective, and sympatholytic effects. Studies are published documenting its safety and efficacy in children when used for sedation following both surgical procedures and non-invasive procedures such as imaging percutaneous biopsies.

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