Panel 4 - Cancel the Case?
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Pregnant Patient with Mediastinal Mass

OBJECTIVES
1) Describe the perioperative risks of pregnant patients with anterior mediastinal masses.
2) To challenge the conventional teaching of risks associated with mediastinal masses in the adult population.
3) Demonstrate the importance of a multidisciplinary approach for the management of high risk patients.

Case Presentation

33 year old female, 28 weeks gestation presents to thoracic surgery with increasing SOB. She is otherwise healthy when over the summer developed cough, asthma and dyspnea. She failed to respond to routine treatments and her CT scan, cardiac MRI and echocardiogram revealed a large anterior mediastinal mass with the following findings:

1) Origin of mass not easily determined
2) Mass occupies almost entire right chest, measuring 19 x 17 x 15 cm
3) No evidence of invasion of lung or other structures
4) Mild displacement and compression of the trachea to the left
5) 50% narrowing of the distal trachea (1.3cm down to 0.8cm down to 0.6cm at the carina)
6) LMB compressed, internal lumen close to 0.5cm
7) RMB severely compressed and then opening up again
8) Obliteration of the RUL, RML partial obstruction, patent RLL
9) SVC compression (severely flattened) but no signs of SVC syndrome
10) Right PA compression but normal main PA
11) Left and right atrial partial compression posteriorly, no hemodynamic compromise
12) Normal heart function and valves
13) No pericardial or pleural effusions

The pregnancy is otherwise normal, with normal fetal size and development. Her respiratory status has improved with steroid therapy to the point where she regularly leaves the hospital to attend to her family’s activities and no longer has orthopnea. Percutaneous biopsies (at least 10-15) were taken and the diagnosis is leiomyoma (benign), which means the treatment is surgical.
Figure 1: Two successive CT scan views of the carina.
Figure 2: Coronal plane CT scan view of the carina.

Questions

Will this patient survive induction of anesthesia?

How can the CT scan help predict the outcome of your induction?

What is the probability of requiring cardiopulmonary bypass?

When and where is it safe to perform surgery?

What disciplines should be consulted?

Should this case be cancelled?
**Perioperative Plan**

The case raises many principles of anesthetic care that are difficult to balance. Very few anesthesiologists have regular exposure to cases like this which adds to the uncertainty of what to do(1-4). Guidance from the literature is problematic since it is a collection of case reports offering examples of masses that were treated successfully and unsuccessfully(4). Textbooks are no longer the gold standard since they are often outdated and tend to focus on theoretical principles that are difficult to translate into clinical practice. In addition, what is typically written is unrealistic in most hospitals with the main challenge being successful clinical execution of a plan once it is formulated.

Of upmost importance with this type of case is thorough preoperative planning from a multidisciplinary approach(5-8). The multidisciplinary team included:

1) anesthesiology (thoracic, cardiac and obstetrical specialists)
2) thoracic surgery
3) cardiac surgery
4) neonatology
5) obstetrics
6) nursing (surgery, obstetrics, neonatology)
7) social work

The following plan was agreed upon:

“An attempt will be made to optimize fetal maturity at 32 weeks while observing if maternal deterioration develops from the tumor mass. She is to be transferred to the obstetrical hospital where she will be rounded on daily by the thoracic team. This location was chosen to facilitate the fastest obstetrical response in the event of a crash C-Section (in addition, all other wards were uncomfortable with antenatal patient care).

**Scenario 1: Successfully makes it to 32 weeks**

She will be transferred to a CARDIAC surgery operating room (where CPB backup is available) and the OB anesthesia team will assist in a normal C-section delivery (titrated epidural). Thoracic, cardiac anesthesia and surgery backup will be provided ON SITE, and the proper airway equipment (reinforced ETT and rigid bronchoscope) will be available. OB nurses will be present and the Neonatal Resuscitation Team will take care of the baby and arrange transfer. It is anticipated that this team will need to use the OR adjacent to the room used for C-section. The ICU will have been consulted but most likely the mother will be recovered in a step-down unit. If stable, she will be transferred to the thoracic ward on POD#1 or 2. Mediastinal mass resection will commence about 1 week after C-Section.

**Scenario 2: Fetal distress before 32 weeks**

While at the OB hospital, an urgent/emergent C-section will be arranged by the in-house OB anesthesiologist. Thoracic surgery/anesthesia will be called and the proper airway equipment (reinforced ETT and rigid bronchoscope) will be available, if needed. The obstetricians are aware that a crash general anesthetic
is not the preferred choice. Post-op, the patient would be stabilized and transferred to the thoracic step-down unit (or ICU). Mediastinal mass resection will commence 1 week after C-Section, or earlier if clinically required.

**Scenario 3: Maternal decompression**

Thoracic surgery and anesthesia will be called immediately and the rapidity of intervention will be assessed. The proper airway equipment (reinforced ETT and rigid bronchoscope) will be available, if needed. The fetus will be monitored and when the mother is stable, a C-Section will be planned. The subsequent timing of mediastinal mass surgery will be discussed.

**Preoperative airway plan:**
The course of anesthesia management of her airway will likely depend on who is on call. This group of individuals will be kept to a minimum and an agreement has been reached on a general approach. The CT scan was reviewed in detail with a CT chest radiologist. This is where the measurements of the trachea, distal trachea, carina, LMB listed above came from. A reinforced endobronchial tube would work well and if lung isolation is required, it can directed into the LMB past the tumour. The reinforced tube is helpful in that it won’t compress with manipulation or warmth and it is malleable enough to facilitate LMB placement. Obviously large IV access above and below the diaphragm with appropriate invasive lines should be placed.”

This plan with all scenarios was distributed to all members of the multidisciplinary team in order to maintain clear communication.

**Discussion of Anesthetic Management**

Mediastinal masses have multiple etiologies, including thymoma, thyroid, teratoma, lymphoma, etc. (9,10) Signs and symptoms are numerous but usually include cough, chest pain, dyspnea, hoarseness, orthopnea, superior vena cava (SVC) syndrome, syncope and dysphagia. The structures that may be affected in the superior, anterior and middle mediastinum include the SVC, tracheal bifurcation, PA, aortic arch, atria and ventricles. Consequently, the following anesthetic considerations can be derived:

**ANESTHETIC CONSIDERATIONS:**
1) compression of trachea and/or mainstem bronchi
2) use of armoured endotracheal tube
3) maintenance of spontaneous respiration on induction
4) decreased cardiac output due to vascular compression (atria, right ventricle, PA)
5) echocardiography for hemodynamic compromise
6) SVC syndrome
7) pericardial effusion
8) CT scan evaluation (compression, distance to tumour)
9) lateral or prone position may alleviate instability
10) massive blood loss
11) cardiopulmonary bypass availability
The presence of a fetus significantly elevates the risks imposed by a mediastinal mass. A reduced functional residual capacity coupled with swelling and increased blood volume can significantly diminish the respiratory reserve in pregnant patients(2). Aortocaval compression is even more likely to be problematic in the presence of a mediastinal mass that has SVC involvement. Finally, the acute blood loss at the time of delivery poses a significant insult to the cardiovascular stability in a patient with SVC syndrome and could lead to refractory hypotension.

**Airway Evaluation**

The decision of how to induce this patient was discussed at length and is of primary importance to anesthesiologists. The traditional principle of maintaining spontaneous respiration on induction is based on prevention of airway collapse(6,11). Airway collapse is a rare finding in adult patients(12) but can occur in situations where compression of the trachea is severe (>50%)(13). In severely symptomatic patients general anesthesia is considered unsafe(14). Spontaneous ventilation is more likely to maintain adequate preload than prevention of airway collapse(15). Fatal airway collapse that requires CPB backup primarily reflects observations from the pediatric population(16-19). Infant airways easily collapse even without the presence of tumour but can be predicted if tracheal compression exceeds 50%(20). It is also worth noting that lesions may compress >50% of the trachea but positive pressure ventilation may be initiated if an ETT can be passed past the lesion.

Regardless of what is attempted, maintenance of adequate spontaneous respiration is difficult without added respiratory support due to the effect of general anesthesia(21-23). Flow volume loops can be obtained and a mixed pattern of obstruction and restriction has been shown to be predictive of postoperative respiratory complications(12). However, many studies have shown pulmonary function tests correlate poorly with outcome(14,24). The loss of muscle tone and functional residual capacity is often enough to worsen the obstruction and one should not be lulled into thinking spontaneous respiration will prevent problems(7,25). One published option that might limit FRC loss and muscle tone involves using ketamine and dexmedetomidine as anesthetics(6). Whatever anesthetic agents are used, if spontaneous ventilation is attempted and a patient is forced to generate a strong negative pressure breath due to high resistance, they will undoubtedly fail. This is problematic in diagnostic procedures utilizing a restricted endotracheal tube manipulated with flexible bronchoscopy(26).

In the presented case, the tumour was seen to displace and compress the trachea approximately 50%. Since the obstruction was not fixed, a reinforced endotracheal tube could easily be passed into the left mainstem bronchus, effectively bypassing the tumour. Isolation of the left lung was considered favourable due to the near 100% obstruction of the RMB and severely compromised state of the right lung and its corresponding pulmonary artery.

**Cardiovascular Evaluation**

Often neglected in the discussion of mediastinal masses is vascular stability due to compression of the vena cava, pulmonary arteries and/or pericardium(6,10,27). This evaluation is more important in the adult population and can lead to hemodynamic collapse upon induction. Of particular concern are patients with pericardial effusions and spontaneous respiration may not be adequate to maintain stability(6,15). This introduces the concept of mediastinal mass syndrome(15) which describes
immediate right heart failure secondary to pulmonary artery compression when positive pressure ventilation is initiated. These patients are preload sensitive and any changes brought on by induction can be deleterious. One published approach that can alleviate the effects of poor preload in patients with SVC syndrome is axillo-femoral venous bypass(28,29).

Ventilation-perfusion mismatch due to compression of a bronchus and the contralateral pulmonary artery has been shown to be fatal(30). This refers to asymmetrical obstruction of respiratory and vascular structures. For example, left mainstem bronchial compression in the presence of right pulmonary artery compression can result in severe shunt leading to cardiovascular collapse. Treatments need to be tailored on an individual basis by critically evaluating structures that are affected in order to predict stability post-induction. Risk stratification schemes have been proposed and Blank and de Souza have published a concise approach, which is presented in Table 1. Figure 2 is a proposed algorithm that could be used to guide the decision making process.

The perfect example of a textbook plan for a case like this is to provide cardiopulmonary bypass (CPB)(30-32) or as some case studies have shown, ECMO(33). CPB was discussed in this case. Many physicians would agree that instituting CPB in an emergency situation is conceptually simple but quite difficult to execute, especially in an emergency setting(6,14,17,34) and has no place in the management of these patients.

In this case presentation, the natural progression of leiomyoma tumour growth is very slow, explaining how it was able to become so large before symptom development. This also provided an explanation why there were only minor signs of SVC syndrome. Fortunately, there was no evidence of pericardial effusion. Because it was anticipated that the left mainstem bronchus could be intubated and the main pulmonary artery was patent, it was concluded that CPB was unnecessary. To further justify this approach, our surgical experience has shown that when tumours are resected while on bypass, blood loss can be severe with high rates of mortality. A rescue plan was predetermined in case the patient became unstable and included placing the patient in the right lateral decubitus position(35). This position was chosen based on the known right sided tumour location, anticipating gravity would relieve any worsening obstruction. It should also be noted that at all times rigid bronchscopy was immediately available with the surgeon at the bedside.

**Case Conclusion**

The patient successfully made it to 32 weeks gestation and Scenario #1 above was followed. A routine epidural was placed and the baby was delivered by routine Caesarean section. The patient’s blood pressure did drop significantly with delivery of the baby and placenta but this was stabilized with fluid boluses and small doses of phenylephrine. The procedure was otherwise uneventful and the baby was healthy.

Two thoracic anesthesiologists were assigned to the mediastinal mass resection surgery 1 week post-partum. Induction for the patient was titrated after all lines were placed awake. The patient’s stretcher was left in the operating room in the event the patient needed to be stabilized with positional changes. Cardiorespiratory stability was maintained easily and the patient underwent successful tumour resection through a routine sternotomy. The source of the tumour was found to be the wall of the innominate vein which required resection with creation of a subclavian-right atrial conduit. SVC syndrome developed post-op but this subsided as collateral circulation became more dominant. She
was taken to the ICU and was successfully extubated days later. She has remained disease free for over 13 months.
Table 1: Risk Stratification Approach

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<th>Risk Level</th>
<th>Description</th>
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<tr>
<td>Low Risk</td>
<td>Asymptomatic or mildly symptomatic, without postural symptoms or radiographic evidence of significant compression of structures.</td>
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<tr>
<td>Intermediate Risk</td>
<td>Mild to moderate postural symptoms, tracheal compression &lt;50%.</td>
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<tr>
<td>High Risk</td>
<td>Severe postural symptoms, stridor, cyanosis, tracheal compression &gt;50% or tracheal compression with associated bronchial compression, pericardial effusion or SVC syndrome.</td>
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Published by Blank and de Sousa(9).

Figure 1: Proposed algorithm for clinical decision making with mediastinal masses

Airway Evaluation

Tracheal compression/invasion < 50%

- YES
  - ETT placement possible
- NO
  - (>50% compression or lesion causes fixed tracheal stenosis)

Cardiovascular Evaluation

Vascular compression (Main PA, SVC, atrial compression or pericardial effusion with evidence of hemodynamic compromise)

- YES
  - (high likelihood of cardiovascular collapse on induction)
  - Left PA compression (unstable if right lung or bronchus also compromised)
- NO
  - Right PA compression (unstable if left lung or bronchus also compromised)

High likelihood of airway complications, CPB should be considered
References: