14
Anesthesia for Patients with Mediastinal Masses

Chih Min Ku

Key Points

- Patients with anterior mediastinal masses can develop major airway and cardiovascular compression under general anesthesia, which can be fatal.
- Patients who are symptomatic or have significant compression of these vital structures on CT scans are likely at high risk.
- Where possible, diagnostic procedures should be undertaken under local anesthesia.
- Understanding the relation of the mediastinal mass to vital cardiorespiratory structures, careful preoperative assessment of the patient, discussion with the surgeon, meticulous planning, and preparation for possible perioperative complications related to compression of the major airways and vascular structures are key to successful management.
- Useful strategies to consider include awake fiberoptic intubation, maintenance of spontaneous ventilation, avoidance of muscle relaxants, intubation distal to the airway compression, positioning changes, immediate availability of rigid bronchoscopy, and elective cardiopulmonary bypass in extreme cases.
- A careful anesthetic plan that is not irreversible is likely to result in a good outcome.

Introduction

Mediastinal masses are an uncommon entity. They constitute a heterogeneous group of benign and malignant tumors. The anesthesiologist may provide perioperative care to patients undergoing diagnostic and therapeutic procedures. They can present formidable challenges as mediastinal masses, especially those located in the anterior mediastinum, can cause perioperative morbidity and mortality by causing major airway and vascular compression, which may be exacerbated under general anesthesia. There are numerous case reports of fatal or near fatal complications associated with anesthesia for patients with anterior mediastinal masses [1–5]. Understanding the nature of the mediastinal mass in relation to vital structures, its pathophysiology, careful preoperative assessment of the patient, discussion with the surgeon, and being prepared for management of cardiorespiratory complications related to compression of the trachea and vascular structures are key to successful management.

P. Slinger (ed.), *Principles and Practice of Anesthesia for Thoracic Surgery*,
DOI 10.1007/978-1-4419-0184-2_14, © Springer Science+Business Media, LLC 2011

Anatomy and Pathology

The mediastinum can be divided into four compartments: superior, anterior, middle, and posterior (Fig. 14.1). The mediastinum is bound by the thoracic inlet superiorly, the diaphragm inferiorly, mediastinal pleura laterally, sternum anteriorly, and the vertebral column posteriorly. The superior mediastinum extends from the thoracic inlet to a plane extending from the sternomanubrial junction to the inferior aspect of the fourth thoracic vertebra. The anterior mediastinum is bound anteriorly by the sternum and posteriorly by the pericardium. The middle compartment is bound anteriorly and posteriorly by the pericardium. The posterior mediastinum extends from the posterior pericardium to the anterior longitudinal ligament [6]. Some authors divide the mediastinum into three compartments [7, 8]. Table 14.1 shows the typical masses in the various mediastinal compartments [6, 8]. Most masses are located in the anterior mediastinum. In adults, the common pathologies include thymoma, lymphoma, and germ cell tumor. In the pediatric population, lymphoma, PNET, and neuroblastoma are more common [9].

Anterior mediastinal masses are more likely to cause severe cardiorespiratory problems due to their proximity and relation to the major airway and cardiovascular structures. Any compressive effects can be exacerbated under general anesthesia.

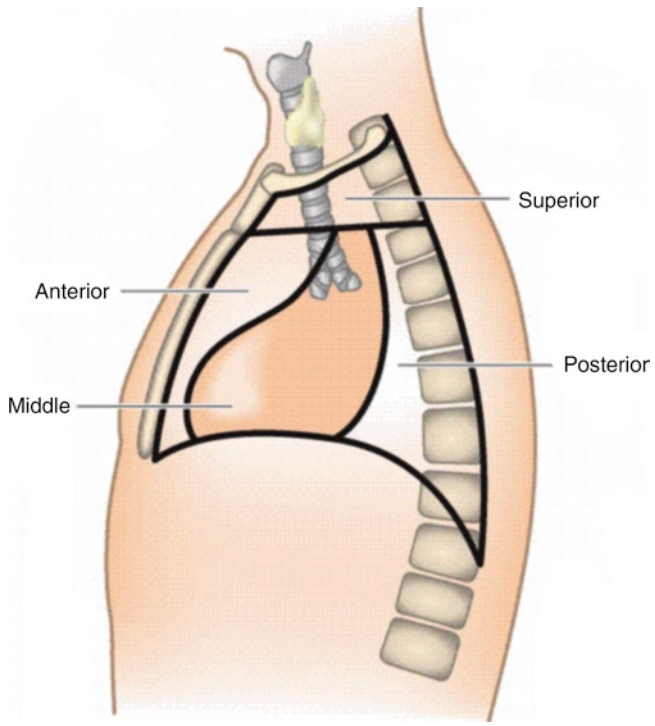

FIG. 14.1. Anatomic location of the four compartments of the mediastinum (reprinted from Warren [6] with permission).

TABLE 14.1. Masses in the mediastinal compartments.

Superior	Retrosternal thyroid
	Thymoma
Anterior	Thymoma
	Lymphoma
	Germ cell tumor
	Thymic cyst
	Parathyroid adenoma
Middle	Bronchogenic cyst
	Cardiac/vascular structure
	Benign adenopathy
	Lymphoma
	Metastases
Posterior	Esophageal mass
	Hiatal hernia
	Neurogenic tumor
	Spine lesions

Clinical Presentation

Tracheobronchial obstruction, superior vena cava syndrome, right heart and pulmonary vascular compression, and systemic syndromes, e.g., myasthenia gravis and thyroid disease are some of the common presentations of mediastinal masses [10]. The patient can also be asymptomatic.

Patients with tracheobronchial obstruction may complain of dyspnea, noisy breathing, nonspecific cough, and chest discomfort. These symptoms may be worse in certain positions, especially the supine position. They may find lying in certain positions more uncomfortable. Signs may include tachypnea, stridor, rhonchi, and decreased breath sounds, which may also be positional in nature. Physical examination is usually unremarkable. The severity of a patient's respiratory symptoms may not correlate with the degree of airway obstruction. Patients with severe respiratory symptoms may have significant decreases in tracheal cross-sectional area [11]. However, asymptomatic pediatric patients have developed airway obstruction during anesthesia [12–14]. Children may present with symptoms of airway obstruction earlier than adults because they have a smaller tracheal diameter and small decreases in tracheal diameter result in large decreases in cross-sectional area and increases in airway resistance [10].

Superior vena cava syndrome, due to obstruction of venous drainage in the upper thorax, may present as dyspnea, CNS symptoms like headache, visual disturbance, altered mentation, dilated collateral veins in the upper body and edema of the face, neck, and arms. Right heart and pulmonary vascular compression can present as dyspnea, syncope during a forced Valsalva maneuver [15], arrhythmias, and cardiac murmur. Symptoms may mimic those of tracheobronchial obstruction. Hence it is important to look for the relation of the mass to the tracheobronchial tree, right heart, and pulmonary vasculature in the radiology scans.

Preoperative Evaluation

The most important aim of preoperative investigation is to identify the size, the relations of the mediastinal mass to the tracheobronchial tree and vital vascular structures, and the location and extent of any compressive effects.

This is best done by radiological studies, mainly chest radiographs and CT scans. CT scans of the thorax provide accurate assessment of the tumor, its nature, size, extent, location, relations to the tracheobronchial tree and major cardiovascular structures, and airway diameters [16]. They are most useful for determining the precise level and extent of tracheobronchial or cardiovascular compression, and this information is essential for formulating the anesthetic plan.

MR imaging is not used routinely. However, it is useful in the diagnosis of neurogenic and vascular lesions, especially when the use of contrast material is contraindicated.

Transthoracic echocardiography can be considered if there is any suspicion of compression or invasion of cardiovascular structures [1], or if a significant pericardial effusion is identified on the CT scan.

Lung function tests and flow volume loops have been used, but their value in the assessment of mediastinal tumors is doubtful. Flow volume loops have been recommended in preoperative evaluation [17]. However, despite their purported ability to quantify the degree of impairment and differentiate extrathoracic from intrathoracic obstruction [18, 19], studies have shown that they correlate poorly with the degree of airway obstruction [20] and do not alter the anesthetic technique [21].

Surgical Approaches

Surgical procedures may be diagnostic or therapeutic. Diagnostic procedures are for the procurement of tissue for biopsy, in order to establish a histological diagnosis and guide treatment. Percutaneous CT-guided needle biopsy, done under local anesthesia, is a safe and cost-effective way of obtaining adequate tissue for histological diagnosis [22]. Other diagnostic procedures that can be done under LA include biopsy of an extrathoracic mass, anterior mediastinotomy [23], anterior mediastinoscopy [24], and endobronchial ultrasound-guided transbronchial needle aspiration. Most mediastinal masses require surgical resection. This can be done safely even if they have invaded surrounding structures [25]. Chemotherapy or radiotherapy may be used for Hodgkin lymphomas. The main surgical approaches include sternotomy, thoracotomy, cervical mediastinoscopy, anterior mediastinoscopy, and video-assisted thoracoscopic surgery. Occasionally, the patient may present for a surgery unrelated to the mediastinal mass [23]. Patients with undiagnosed mediastinal masses undergoing unrelated surgery present extra challenges [26].

Preoperative Treatment

Patients with mediastinal masses causing significant respiratory or cardiovascular compression are at high risk of cardiopulmonary collapse under general anesthesia. They may benefit from preoperative treatment of the mediastinal mass with steroids, chemotherapy, or radiotherapy, in order to shrink the tumor and alleviate the obstruction [11, 27–30]. Preoperative radiation therapy due to severe clinical or radiological findings has been associated with a decrease in postoperative respiratory complications [31]. However, tumor shrinkage can affect the accuracy of a histological diagnosis and cause diagnostic confusion. There is considerable controversy over the role of pretreatment. It has been reported that tissue diagnosis was not affected if biopsies were taken within 72 h of starting treatment [28]. Hack et al. found that a clear diagnosis was made in 95% of children considered high risk who were given steroids prior to diagnosis [29]. Ferrari et al. believe that pretreatment affects accuracy of histological diagnosis and prefer to acquire a tissue diagnosis before starting treatment. In their series, which included high-risk patients, 9 of the 44 pediatric patients who required general anesthesia were symptomatic preoperatively. No pretreatment was given before general anesthesia. There was no perioperative death or permanent injury, despite the occurrence of perioperative cardiorespiratory compromise, which was successfully managed [32]. The risk of intraoperative cardiopulmonary collapse during a diagnostic procedure, where general anesthesia is necessary, must be weighed carefully against the risk of diagnostic inaccuracy of preoperative treatment, in patients with large anterior mediastinal masses causing considerable cardiopulmonary compromise.

Anesthetic Management

Options include local anesthesia or general anesthesia, depending on the nature of the surgery. Discussion with the surgeon regarding the type of tumor, presence and degree of tracheobronchial and cardiovascular compression, the surgical approach, type of anesthesia, and other options, is paramount.

Biopsy under local anesthesia is ideal for large anterior mediastinal masses, especially if the patient is symptomatic [11]. This may be difficult in children. Pretreatment of large tumors can be considered, bearing in mind the possible adverse effects of pretreatment on the accuracy of histological diagnosis.

The dangers of general anesthesia in patients with mediastinal masses have been emphasized by many authors [33–36]. Postulated reasons for the dangers of general anesthesia include the fact that lung volume is reduced under general anesthesia and relaxation of bronchial smooth muscle leads to greater compressibility of the airway from the overlying mass. Muscle relaxant-induced paralysis of the diaphragm reduces

the normal transpleural pressure gradient which dilates the airway. This decreases the caliber of the airways and enhances the effect of extrinsic compression [1].

For procedures under general anesthesia, standard monitors and good intravascular access are routine. Invasive monitoring of blood pressure is preferably established preinduction, in view of possible hemodynamic instability. The necessity of insertion of central venous catheter and the use of transesophageal echocardiography depend on the patient's comorbidities and nature of the mediastinal mass.

Induction and Intubation

In patients with tracheobronchial obstruction undergoing GA, the technique of induction and intubation depends on the site and extent of tracheobronchial obstruction. This can include awake fiberoptic intubation [37–39], inhalational induction [12, 32], and routine intravenous induction. Awake fiberoptic intubation allows assessment of the level and degree of tracheobronchial compression [37–39]. The least obstructed bronchus can also be identified [38] to permit planning of subsequent rescue procedures which may be necessary later. Awake fiberoptic intubation is likely the safest technique of airway management because the patient is breathing spontaneously without any of the deleterious effects of general anesthesia. It is the most reversible technique, can be aborted at any point, and can be done in pediatric patients as well [37]. If CT scans suggest intubation distal to the obstruction is possible, awake fiberoptic intubation is probably the safest technique in patients who are symptomatic from large anterior mediastinal masses causing significant or distal tracheobronchial obstruction. Inhalational induction, if contemplated, should be used judiciously, as a partially obstructed respiration can generate large negative pressures which can further collapse a compressed trachea. An inhalational induction can actually precipitate airway obstruction [37]. Aborting a semi-obstructed inhalation induction midcourse is potentially difficult and hazardous. The likelihood of supraglottic upper airway obstruction, which may further compound the problem, should be carefully assessed before embarking on this technique. It may also have limitations in the obese patient. If a patient has no clinical or radiological evidence of airway or cardiovascular compression from a small mediastinal mass, a routine intravenous induction with or without ketamine can be performed carefully. Extra care must be taken in children because asymptomatic or minimally symptomatic children have experienced severe complications during anesthesia [12–14, 27, 40].

Maintenance of spontaneous ventilation and avoidance of paralysis are advocated to avoid complete airway obstruction by preserving normal transpulmonary pressure and maintaining airway patency [30, 41]. If paralysis is used, muscle relaxants with short duration should be given only when a definite airway and the ability to ventilate are certain. Problems with ventilation have often been encountered after paralysis [1, 38] despite the apparent prior ability to control ventilation [1].

If intubation is planned, the anesthesiologist aims to intubate distal to the level of tracheobronchial obstruction, which may occasionally entail endobronchial intubation [12]. Endotracheal tubes long enough to intubate a mainstem bronchus if necessary [37, 42], endobronchial tubes, and microlaryngeal tubes [12] should be immediately available. Occasionally, when intubation distal to the tracheobronchial obstruction is not possible, other measures which may be useful include distal jet ventilation catheter via a proximally intubated trachea and rigid bronchoscopy [1, 42]. Rigid bronchoscopy, which should always be on standby with a skilled surgeon, allows assessment of the most patent airway, provides a conduit for jet ventilation, and stenting of the airway, if feasible. The futility of controlling ventilation of a patient with distal tracheobronchial obstruction through a proximal airway has been described [1]. Occasionally, intubation can precipitate or exacerbate obstruction, which may be relieved by the return of spontaneous respiration [13, 43]. The maintenance of spontaneous ventilation if one is uncertain of the ability to intubate distal to the obstruction cannot be overemphasized.

Positioning changes may be necessary to alleviate airway obstruction after induction. Lateral, semierect, or prone positioning may be used [13, 44]. Occasionally, patients may require induction in a semierect or full sitting position [32]. Information regarding the patient's most comfortable breathing position will prove useful. Sufficient help in turning patients emergently should be immediately available.

Other techniques reported to manage airway obstruction include the use of direct laryngoscopy with the endotracheal tube in situ [14], percutaneous needle aspiration of the mass under LA preinduction [45], and bronchoscopic intubation with the aid of a laryngeal mask airway and intubation catheter [46].

In cases of severe respiratory or hemodynamic compromise after induction not responding to ventilation attempts including rigid bronchoscopy or positional changes, the surgeon may have to proceed quickly to an emergent sternotomy to lift the anterior mediastinal mass to alleviate its compressive effects. Severe hypoxia refractory to treatment with oxygen and ventilation may indicate cardiac compression from the mediastinal mass [47].

Ventilation

Ventilation after intubation depends on whether intubation is distal to the tracheobronchial obstruction. If that is certain, one can gradually take over the ventilation manually, and if this is well tolerated, positive pressure ventilation with or without short-acting muscle relaxants can be employed. If there is doubt about certainty of distal intubation or ability to ventilate, maintenance of spontaneous ventilation [30, 32] seems reasonable, with occasional assisted ventilation.

Other Issues

Specific issues pertaining to SVC obstruction include the possibility of excessive bleeding, the certainty of drug delivery to the effector site, and the possibility of airway swelling and stridor during emergence and after surgery. Large bore IV access established in the lower limbs [32], including possible central venous catheter in the femoral vein, immediate availability of blood, and postoperative ventilation may be necessary, especially if surgery is prolonged. Occasionally, the surgeons may need to clamp or resect the SVC.

Specific considerations for patients with myasthenia gravis will be dealt with in Chap. 15.

Cardiopulmonary bypass can be considered in situations when the ability to ventilate is unlikely or uncertain after induction, e.g., if the tumor compresses the distal third of the trachea, both mainstem bronchi or the carina. It can also be used when there is extensive tumor compression of the right heart or pulmonary artery, with significant risk of hemodynamic collapse after induction. Cardiopulmonary bypass, if planned, should always be established electively before induction [48, 49], as its use in an emergent rescue situation is unlikely to result in a favorable outcome [50]. Even a planned preinduction cardiopulmonary bypass can be difficult to execute [51]. It therefore requires advance planning and discussion with the surgical and perfusion teams. Soon et al. described in their case report the preinduction establishment of peripheral cardiopulmonary bypass for resection of a large thymoma causing severe tracheobronchial and superior vena cava compression. They instituted peripheral venoarterial bypass under local anesthesia with light sedation, with the arterial inflow via the common femoral artery, and the venous cannula directed up the femoral vein to the right atrium. After the establishment of cardiopulmonary bypass, the patient underwent inhalational induction and was intubated without relaxant. Only after decompression of the cystic tumor, when mechanical ventilation was certain, was the patient weaned from bypass [49].

Emergence and Recovery

Emergence and recovery may be complicated by airway obstruction, especially in diagnostic surgeries when the anterior mediastinal mass is not removed [1]. There is also risk of glottic edema and post-op stridor, in patients with SVC obstruction and prolonged surgeries. Complications involving the airway may be more common upon emergence and in the recovery period [52]. Extubation of the airway should only be done if the patient is completely awake and obeying commands, with full recovery of muscle strength. The use of short-acting anesthetic agents, narcotics, and muscle relaxants may be advantageous. Even with apparently successful extubation, the patient should be carefully monitored in the postanesthetic care unit, with the anesthesiologist prepared to emergently reintubate the patient, because any deterioration may be rapid.

Complications and Risk Factors

Complete airway obstruction and cardiovascular collapse are the most-feared complications that can occur during general anesthesia in patients with mediastinal masses [2, 3, 53]. Exacerbation of the compressive effects on the major airways [27, 43, 53] and cardiovascular structures (heart, pulmonary artery, superior vena cava) [53, 54] can result in profound hypoxemia and hypotension. They can occur unexpectedly at any time during anesthesia including preinduction, induction, positioning, surgery, emergence and extubation, or postoperatively in the PACU [1–3, 11, 27, 37, 43, 51]. The incidence of complications has been reported to be between 7 and 20%, mainly in the pediatric population [11, 27, 32, 55]. Bechard et al., in their adult series, reported the incidence of intraoperative cardiorespiratory and postoperative respiratory complications as 3.8 and 10.5%, respectively. The incidence of intraoperative airway obstruction was 0% in their series [52].

Various authors have attempted to identify risk factors predictive of perioperative cardiorespiratory complications. Studies were mainly performed in pediatric populations [11, 55–57]. In children, the anterior mediastinal masses associated with anesthetic problems are rapidly growing hematological malignancies [58]. King et al. proposed that respiratory symptoms were accurate indicators of significance of airway compression and risk of general anesthesia [55]. Hack et al. reported a poor correlation between clinical signs and size of tumor or tracheal compression on CT scan. They found stridor to be the only sign that predicted an anesthetic complication. Respiratory complications were found in patients with tracheal cross-sectional area less than 30% normal or less than 70% and associated with bronchial compression [29]. Azizkhan et al. reported a high rate of total airway obstruction during general anesthesia in children with tracheal compression greater than 50% [11]. Shamberger et al. concluded in their prospective study that general anesthesia could be given to children with tracheal area and peak expiratory flow rate greater than 50% of predicted [57]. Bechard et al. reported a high perioperative complication rate for adult patients with severe symptoms (stridor, orthopnea, cyanosis, jugular distension, SVC syndrome) in their univariate analysis. They found no perioperative complications in asymptomatic patients. Intraoperative complications were associated with pericardial effusion on CT scan. Postoperative respiratory complications were associated with tracheal compression of more than 50% on CT scan and combined obstructive and restrictive pattern on pulmonary function tests [52].

Anesthesia for Mediastinoscopy

Mediastinoscopy is a procedure widely used for staging of lung malignancy and for obtaining tissue for histological diagnosis of mediastinal masses. The two main approaches

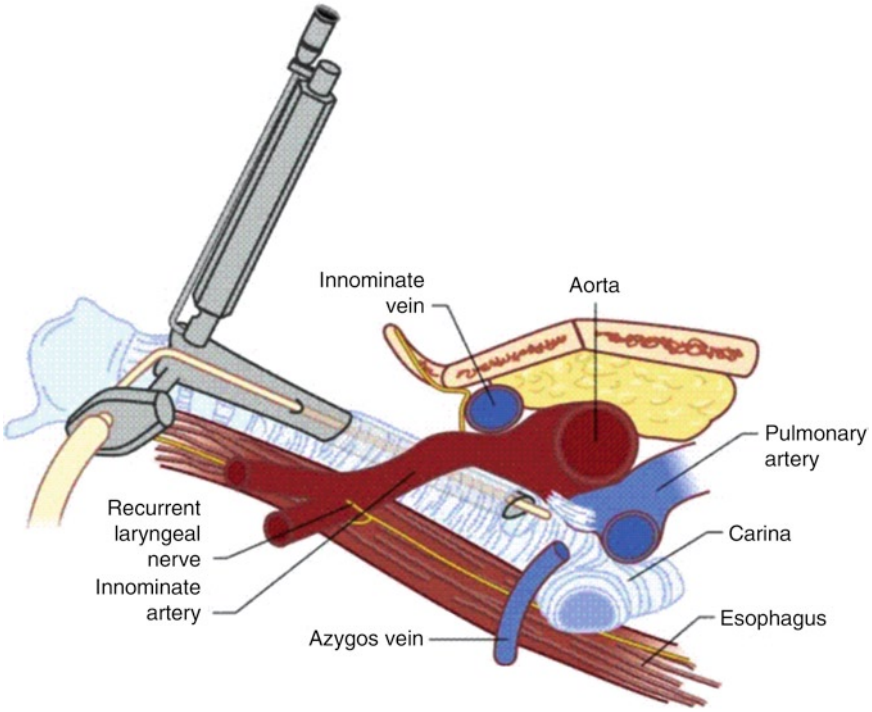

Fig. 14.2. Diagram of a mediastinoscope in the pretracheal fascia along with relevant surrounding structures. Note the innominate artery immediately anterior to the mediastinoscope. The azygos vein drains into the superior vena cava, which has been omitted from the drawing because it would cover the location of the mediastinoscope (reprinted from Slinger and Campos [61] with permission).

are cervical mediastinoscopy and anterior mediastinoscopy. Far more common is cervical mediastinoscopy, where the scope is inserted beneath the manubrium and requires general anesthesia. Anterior mediastinoscopy is done via the second left interspace to inspect the lower left mediastinum. It can be done under local anesthesia [24].

Because the mediastinoscope is inserted near major blood vessels like the innominate artery and azygos vein, there is a risk of massive hemorrhage which can be life-threatening (Fig. 14.2). In a retrospective review, Park et al. reported the incidence of major hemorrhage as 0.4% [59]. The most frequently injured vessels were the azygos vein and the innominate and pulmonary arteries [59]. Other complications include compression of the trachea, compression of the innominate artery that can lead to cerebrovascular events and right upper limb ischemia, compression of the aorta leading to reflex bradycardia, pneumothorax, injury to the recurrent laryngeal nerve, and air embolism.

In addition to the anesthetic concerns for management of a mediastinal mass, the perioperative care of a patient undergoing mediastinoscopy has some unique considerations. There should be monitoring of the right upper limb pulse, either by pulse oximetry placed on a right finger or by invasive blood pressure established in the right upper limb. The noninvasive blood pressure can be measured from the left arm to ascertain systemic pressures. As there is a potential for massive hemorrhage, large-bore venous access is ideal. Lower limb venous access can be considered and availability of blood ascertained. General anesthesia with positive pressure ventilation via a single lumen endotracheal tube is usually used, with the patient in a supine position on a shoulder roll. The surgeon may have to be alerted to excessive compression of the innominate artery (hence compression of the right common carotid) or the trachea by the mediastinoscope. Attention to the right arm arterial waveform and the peak inspiratory pressure is necessary.

In the event of bleeding, immediate preparations for resuscitation of massive hemorrhage should be undertaken, because patients can exsanguinate, while the surgeon tries to stop the bleeding. Initial control of the bleeding may be achieved through packing [59, 60]. There may be a necessity of conversion to a sternotomy or a thoracotomy [60], depending on the site of bleeding. Lung isolation, if necessary, may be done via a change to a double-lumen tube [60] but a bronchial blocker may be more useful in such extraneous circumstances, especially in a patient with a difficult airway. Lower limb venous access and invasive blood pressure monitoring should be established quickly, if not done previously. There should be immediate availability of blood and equipment for massive blood transfusion, including rapid transfusion devices, blood warmers, and possibly cell savers.

Patients can usually be extubated immediately after uncomplicated mediastinoscopy and may be discharged on the same day after a postoperative chest radiograph done to rule out the infrequent pneumothorax.

Summary

Anesthesia for patients with anterior mediastinal masses remains a challenge for the anesthesiologist. Attempting to identify patients at high risk for airway occlusion and

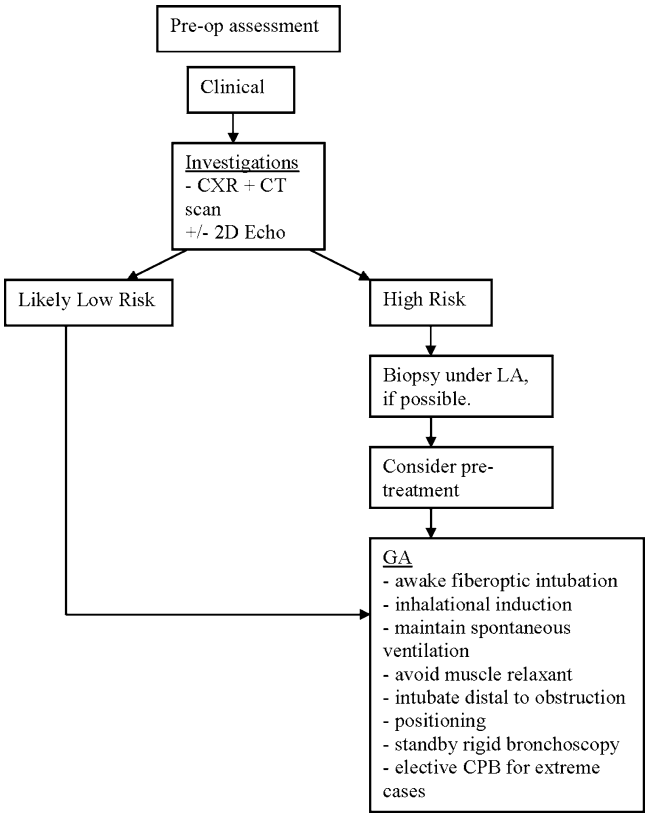

FIG. 14.3. Flow chart showing the anesthetic considerations for patients with anterior mediastinal masses.

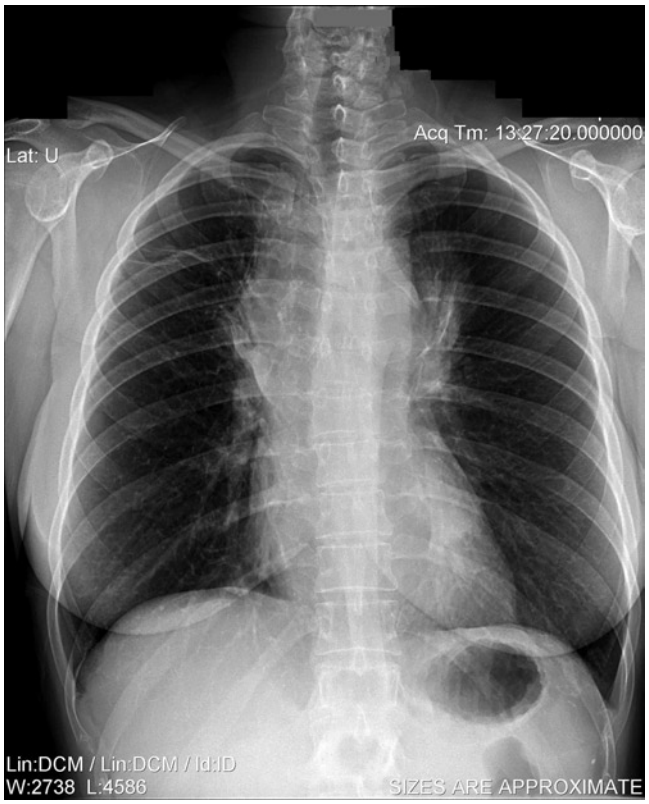

FIG. 14.4. Chest X-ray of a middle-aged woman with a recurrent anterior mediastinal mass and history of treated Hodgkin's lymphoma presenting for biopsy of the mass under GA. Recent percutaneous CT-guided biopsies were nondiagnostic. She was asymptomatic.

cardiovascular collapse under general anesthesia continues to be difficult. Where possible, diagnostic procedures should be undertaken under local anesthesia. Understanding the relation of the mediastinal mass to vital structures, careful preoperative assessment of the patient, discussion with the surgeon, and careful planning and preparation for perioperative complications related to compression of the major airways and vascular structures are key to successful management. A careful anesthetic plan that is not irreversible is likely to result in a good outcome (see Figs. 14.3–14.6).

Clinical Case Discussion

A middle-aged obese woman with a history of asthma presents with a large anterior mediastinal mass for sternotomy and resection. She has vague symptoms of orthopnea, requiring two pillows to sleep. CT scan shows a 4 by 5-cm mass in the anterior mediastinum causing compression on the mid to distal trachea, with about 50% decrease in the cross-sectional area of the trachea in the narrowest portion.

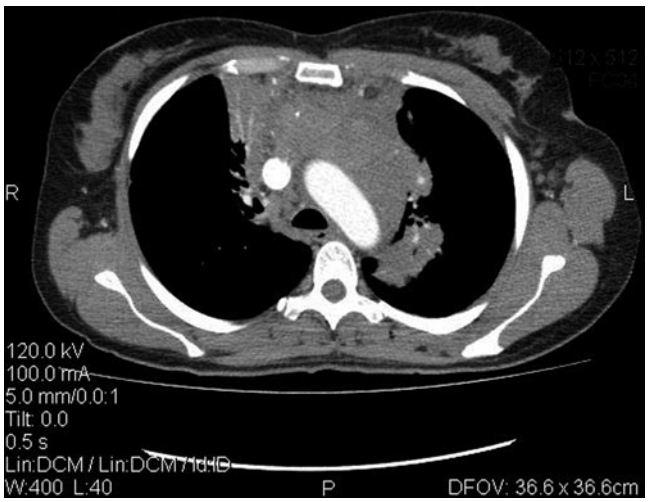

FIG. 14.5. CT scan of the same patient shows a large anterior mediastinal mass measuring 4.2 cm in its AP diameter. There is no obvious compression of the major airways or vascular structures. GA was uneventful and included a conventional intravenous induction with propofol and paralysis with succinylcholine for intubation. Biopsy eventually revealed a diagnosis of recurrent Hodgkin's lymphoma.

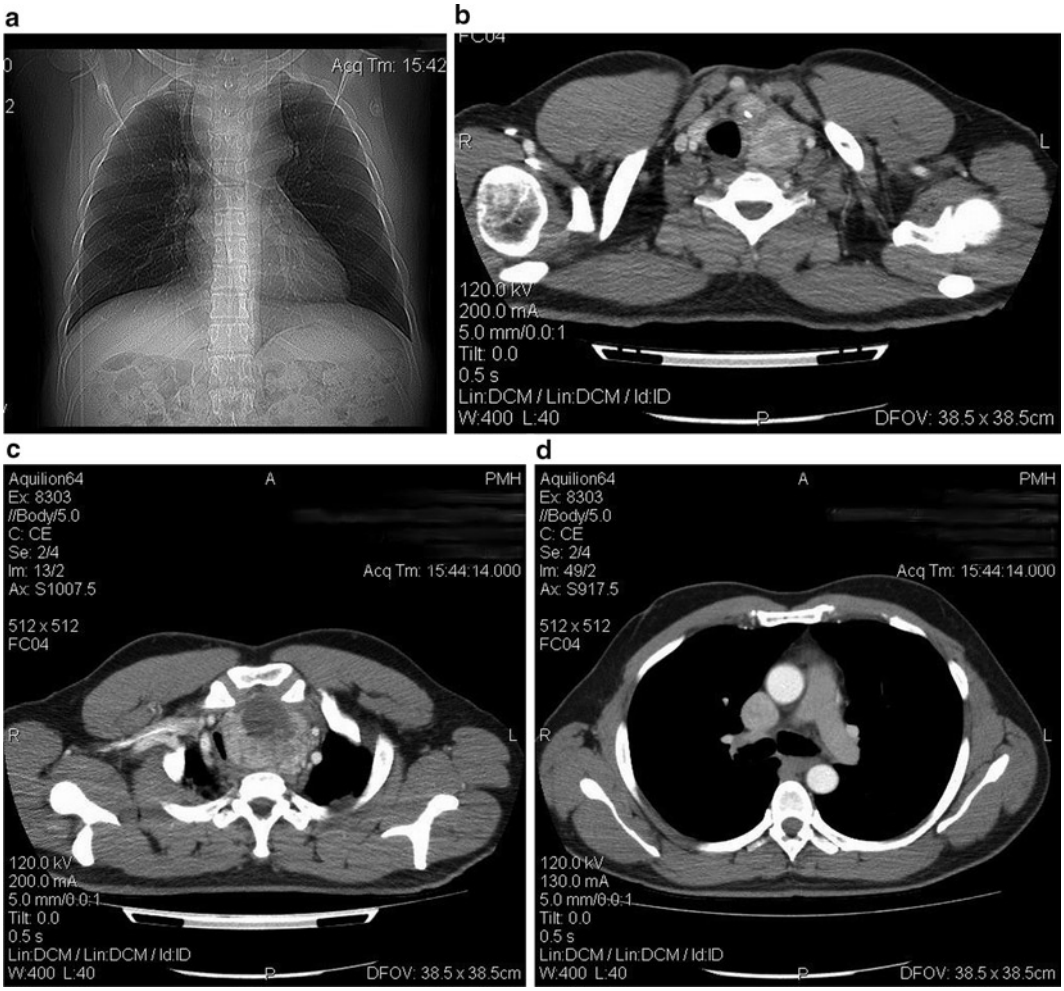

Fig. 14.6. (**a**) Chest X-ray of a 55-year-old female patient with mid-thoracic tracheal compression from an intrathoracic goiter. It shows trachea compression and deviation to the right. (**b**) CT scan of the same patient with mid-thoracic tracheal compression from an intrathoracic goiter. It shows the mediastinal mass pushing the trachea to the right. (**c**) CT scan of the patient with mid-thoracic tracheal compression from an intrathoracic goiter. It shows the trachea compressed to almost a slit by the mass. (**d**) CT scan of the patient with mid-thoracic tracheal compression from an intrathoracic goiter. It shows right and left main stem bronchi, relatively free from compressive effects. This patient was intubated distal to the stenosis awake.

Question 1

What are your options for induction of anesthesia?

Answer

This lady likely falls in the high risk category, in view of her symptoms and CT scan findings. The options include awake fiberoptic intubation and inhalational induction. The safest option is likely to be the former, which permits inspection of level of obstruction, the diameter of the airway, the least obstructed bronchus, and the passage of an endotracheal tube long enough to intubate distal to the obstruction. In this obese patient, an inhalational induction may be difficult, with partially obstructed respiration being a potential problem, and this technique may be difficult to abort midway.

Question 2

You successfully intubated the patient and gave a muscle relaxant. Soon after, the airway pressure rises to above 40 cm H_2O. Auscultation reveals bilateral rhonchi. She starts to desaturate rapidly. What do you suspect?

Answer

The diagnosis to exclude urgently is intubation proximal to the trachea obstruction. A quick check with the bronchoscope will help verify this. Pushing the endotracheal tube further in may result in improvement if that were indeed the problem, if it is possible to bypass the obstruction. Occasionally, endobronchial intubation may be necessary, but it may also cause hypoxemia, unless bilateral bronchi are intubated.

One should suspect that the obstruction is more distal than initially thought if one cannot bypass the obstruction, e.g., bilateral bronchi are obstructed as well. Paralysis and loss of spontaneous ventilation will exacerbate the problem of a proximal intubation. One should be very careful with muscle relaxants, using them only when ventilation is certain. If there are any doubts, avoid them.

The presence of rhonchi may suggest bronchospasm but that is usually a red herring. The most likely and urgent diagnosis to exclude is major airway obstruction. Rhonchi and high airway pressures may be the only clues to airway obstruction and should not automatically be attributed to peripheral bronchospasm in a patient with an anterior mediastinal mass.

The other important differential to consider in this patient is compression of major cardiovascular structures.

Question 3

The airway pressure continues to be high and the patient continues to desaturate despite your attempts at bronchoscopic adjustment of the endotracheal tube. The surgeons are scrubbing. What should you do?

Answer

Immediately alert the surgeon, who may want to do an urgent rigid bronchoscopy or proceed to immediate sternotomy to lift the medistinal mass to relieve its compressive effects. Equipment should be on standby and immediately available. Changing the position of the patient may help. Endobronchial intubation may be attempted if the tube is long enough. Jet ventilation via a proximally intubated trachea may be considered.

The surgeons quickly performed a sternotomy and upon lifting the mass off the trachea and the right pulmonary artery, the airway pressure and saturation improved dramatically. That was the longest minute of your life!

References

1. Neuman GG, Weingarten AE, Abramowitz RM, Kushins LG, Abramson AL, Ladner W. The anesthetic management of the patient with an anterior mediastinal mass. Anesthesiology. 1984;60:144–7.
2. Levin H, Bursztein S, Heifetz M. Cardiac arrest in a child with an anterior mediastinal mass. Anesth Analg. 1985;64:1129–30.
3. Northrip DR, Bohman BK, Tsueda K. Total airway occlusion and superior vena cava syndrome in a child with an anterior mediastinal tumour. Anesth Analg. 1986;65:1079–82.
4. Victory RA, Casey W, Doherty P, Breatnach F. Cardiac and respiratory complications of mediastinal lymphomas. Anaesth Intens Care. 1993;21:366–9.
5. Hammer GB. Anaesthetic management for the child with a mediastinal mass. Paediatr Anaesth. 2004;14:95–7.
6. Warren WH. Anatomy of the mediastinum with special reference to surgical access. In: Pearson's thoracic and esophageal surgery. 3rd ed. Elsevier; 2009. Chapter 122. p. 1472.
7. DeCamp MM, Swanson SJ, Sugarbaker DJ. The mediastinum. In: Baue AE, Geha AS, Laks H, Hammond GL, Naunheim KS, editors. Glenn's thoracic and cardiovascular surgery. 6th ed. Appleton & Lange: Stamford; 1996. p. 643–63.
8. Yoneda KY, Louie S, Shelton DK. Mediastinal tumors. Curr Opin Pulm Med. 2001;7:226–33.
9. Dubashi B, Cyriac S, Tenali SG. Clinicopathological analysis and outcome of primary mediastinal malignancies – a report of 91 cases from a single institute. Ann Thorac Med. 2009;4:140–2.
10. Davis RDJ, Oldham HNJ, Sabiston DCJ. Primary cysts and neoplasms of the mediastinum: recent changes in clinical presentation, methods of diagnosis, management, and results. Ann Thorac Surg. 1987;44:229–37.
11. Azizkhan RG, Dudgeon DL, Buck JR, Colombani PM, Yaster M, Nichols D, et al. Life-threatening airway obstruction as a complication to the management of mediastinal masses in children. J Pediatr Surg. 1985;20:816–22.
12. John RE, Narang VP. A boy with an anterior mediastinal mass. Anaesthesia. 1988;43:864–6.
13. Bray RJ, Fernandes FJ. Mediastinal tumour causing airway obstruction in anaesthetized children. Anaesthesia. 1982;37:571–5.
14. DeSoto H. Direct laryngoscopy as an aid to relieve airway obstruction in a patient with a mediastinal mass. Anesthesiology. 1987;67:116–7.
15. Froese AB, Bryan AC. Effects of anesthesia and paralysis on diaphragmatic mechanics in man. Anesthesiology. 1974;41:242–55.
16. Graeber GM, Shriver CD, Albus RA, Burton NA, Collins GJ, Lough FC, et al. The use of computed tomography in the evaluation of mediastinal masses. J Thorac Cardiovasc Surg. 1986;91:662–6.
17. Benumof JL. Anesthesia for thoracic surgery. 2nd ed. Philadelphia: Saunders; 1995. p. 570.
18. Prakash UB, Abel MD, Hubmayer RD. Mediastinal mass and tracheal obstruction during general anesthesia. Mayo Clin Proc. 1988;63:1004–11.
19. Miller RD, Hyatt RE. Obstructing lesions of the larynx and trachea: clinical and physiologic characteristics. Mayo Clin Proc. 1969;44:145–61.
20. Vander Els NJ, Sorhage F, Bach AM, Straus DJ, White DA. Abnormal flow volume loops in patients with intrathoracic Hodgkin's disease. Chest. 2000;117:1256–61.
21. Hnatiuk OW, Corcoran PC, Sierra A. Spirometry in surgery for anterior mediastinal masses. Chest. 2001;120:1152–6.
22. Kulkarni S, Kulkarni A, Roy D, Thakur MH. Percutaneous computed tomography guided-core biopsy for the diagnosis of mediastinal masses. Ann Thorac Med. 2008;3:13–7.
23. Dasan J, Littleford J, McRae K, Farine D, Winton T. Mediastinal tumor in a pregnant patient presenting as acute cardiorespiratory compromise. Int J Obstet Anesth. 2002;11:52–6.
24. Rendina EA, Venuta F, De Giacomo T, Ciccone AM, Moretti MS, Ibrahim M, et al. Biopsy of anterior mediastinal masses under local anesthesia. Ann Thorac Surg. 2002;74:1720–2.
25. Bacha EA, Chapelier AR, Macchiarini P, Fadel E, Dartevelle PG. Surgery for invasive primary mediastinal tumors. Ann Thorac Surg. 1998;66:234–9.
26. Szokol JW, Alspach D, Mehta MK, Parilla BV, Liptay MJ. Intermittent airway obstruction and superior vena cava syndrome in a patient with an undiagnosed mediastinal mass after cesarean delivery. Anesth Analg. 2003;97:883–4.

27. Piro A, Weiss D, Hellman S. Mediastinal Hodgkin's disease: a possible danger for intubation anesthesia. Int J Radiat Oncol Biol Phys. 1976;1:415–9.
28. Robie DK, Gursoy MS, Pokorny WJ. Mediastinal tumors – airway obstruction and management. Semin Pediatr Surg. 1994;3: 259–66.
29. Hack HA, Wright NB, Wynn RF. The anaesthetic management of children with anterior mediastinal masses. Anaesthesia. 2008;63:837–46.
30. Sibert KS, Biondi JW, Hirsch NP. Spontaneous respiration during thoracotomy in a patient with a mediastinal mass. Anesth Analg. 1987;66:904–7.
31. Turoff RD, Gomez GA, Berjian R, Park JJ, Priore RL, Lawrence DD, et al. Postoperative respiratory complications in patients with Hodgkin's disease: relationship to the size of the mediastinal tumor. Eur J Cancer Clin Oncol. 1985;21:1043–6.
32. Ferrari LR, Bedford RF. General anesthesia prior to treatment of anterior mediastinal masses in pediatric cancer patients. Anesthesiology. 1990;72:991–5.
33. Pullerits J, Holzman R. Anaesthesia for patients with mediastinal masses. Can J Anaesth. 1989;36:681–8.
34. Greengrass R. Anaesthesia and mediastinal masses. Can J Anaesth. 1990;37:596–7.
35. Tinker DT, Crane DL. Safety of anesthesia for patients with anterior mediastinal masses I. Anesthesiology. 1990;73:1060.
36. Zornow MH, Benumof JL. Safety of anesthesia for patients with anterior mediastinal masses II. Anesthesiology. 1990;73:1061.
37. Mackie AM, Watson CB. Anaesthesia and mediastinal masses. Anaesthesia. 1984;39:899–903.
38. Goh MH, Liu XY, Goh YS. Anterior mediastinal masses: an anaesthetic challenge. Anaesthesia. 1999;54:670–82.
39. Narang S, Harte BH, Body SC. Anesthesia for patients with a mediastinal mass. Anesthesiol Clin North Am. 2001;19: 559–79.
40. Shamberger RC. Preanesthetic evaluation of children with anterior mediastinal masses. Semin Pediatr Surg. 1999;8:61–8.
41. Frawley G, Low J, Brown TCK. Anaesthesia for an anterior mediastinal mass with ketamine and midazolam infusion. Anaesth Intens Care. 1995;23:610–2.
42. Stewart AS, Smythe WR, Aukburg S, Kaiser LR, Fox KR, Bavaria JE. Severe acute extrinsic airway compression by mediastinal tumor successfully managed with extracorporeal membrane oxygenation. ASAIO J. 1998;44:219–21.
43. Bittar D. Respiratory obstruction associated with induction of general anesthesia in a patient with mediastinal Hodgkin's disease. Anesth Analg. 1975;54:399–403.
44. O'Leary HT, Tracey JA. Mediastinal tumours causing airway obstruction: a case in an adult. Anaesthesia. 1983;38:67.
45. Flaherty S, Grishkin BA. Airway obstruction by anterior mediastinal mass. Successful management by percutaneous aspiration. Chest. 1994;106:947–8.
46. Capdeville M. The management of a patient with tracheal compression undergoing combined resection of an anterior mediastinal mass and aortic valve replacement with coronary artery bypass graft surgery: utility of the laryngeal mask airway and Aintree intubation catheter. J Cardiothorac Vasc Anesth. 2007;21:259–61.
47. Russell JC, Lowry KG. Presentation of non-Hodgkin's lymphoma as acute hypoxia caused by right ventricular compression. Anesth Analg. 2003;96:1768–71.
48. Tempe DK, Arya R, Dubey S, Khanna S, Tomar AS, Grover V, et al. Mediastinal mass resection: femerofemoral cardiopulmonary bypass before the induction of anaesthesia in the management of airway obstruction. J Cardiothorac Vasc Anesth. 2001;15:233–6.
49. Soon JL, Poopalalingam R, Lim CH, Koong HN, Agasthian T. Peripheral cardiopulmonary bypass-assisted thymoma resection. J Cardiothorac Vasc Anesth. 2007;21:867–9.
50. Turkoz A, Gulcan O, Tercan F. Hemodynamic collapse caused by a large unruptured aneurysm of the ascending aorta in an 18 year old. Anesth Analg. 2006;102:1040–2.
51. Asai T. Emergency cardiopulmonary bypass in a patient with a mediastinal mass. Anaesthesia. 2007;62:859–60.
52. Bechard P, Letourneau L, Lacasse Y, Cote D, Bussieres JS. Perioperative cardiorespiratory complications in adults with mediastinal mass. Anesthesiology. 2004;100:826–34.
53. Keon TP. Death on induction of anesthesia for cervical node biopsy. Anesthesiology. 1981;55:471–2.
54. Goodman R. Superior vena cava syndrome. Clinical management. JAMA. 1975;231:58–61.
55. King DR, Patrick LE, Ginn-Pease ME, McCoy KS, Klopfenstein K. Pulmonary function is compromised in children with mediastinal lymphoma. J Pediatr Surg. 1997;32:294–9.
56. Shamberger RC, Holzman RS, Griscom NT, Tarbell NJ, Weinstein HJ. CT quantification of tracheal cross-sectional area as a guide to the surgical and anesthetic management of children with anterior mediastinal masses. J Pediatr Surg. 1991;26: 138–42.
57. Shamberger RC, Holzman RS, Griscom NT, Tarbell NJ, Weinstein HJ, Wohl ME. Prospective evaluation by computed tomography and pulmonary function tests of children with mediastinal masses. Surgery. 1995;118:468–71.
58. King RM, Telander RL, Smithson WA, Banks PM, Han MT. Primary mediastinal tumors in children. J Pediatr Surg. 1982;17:512–20.
59. Park BJ, Flores R, Downey RJ, Bains MS, Rusch VW. Management of major hemorrhage during mediastinoscopy. J Thorac Cardiovasc Surg. 2003;126:726–31.
60. Lohser J, Donington JS, Mitchell JD, Brodsky JB, Raman J, Slinger P. Case 5 – 2005: anesthetic management of major hemorrhage during mediastinoscopy. J Cardiothorac Vasc Anesth. 2005;19:678–83.
61. Slinger PD, Campos JH. Anesthesia for thoracic surgery. In: Miller RD, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Young WL, editors. Miller's anesthesia. 7th ed. Amsterdam: Elsevier; 2009. p. 1856.