

**Editorial**

Anterior mediastinal masses and anesthesia in children: how far have we come along?

Anesthetic management of diagnostic and surgical procedures in children with anterior mediastinal mass may present life-threatening challenges. Closed claims data from the Australasian Incident Monitoring Study, the United Kingdom Medical Defence Union, and the ASA before 2001 indicated a total of 8 adverse events and claims related to anterior mediastinal mass [1]. The majority of patients were under 18 years of age (7 of 8 claims), and most cases occurred in patients under the age of 8 years (6 of 8 claims). These patients underwent a seemingly trivial procedure, ie, a diagnostic biopsy, and yet 8 patients suffered severe brain damage and death [1]. The common descriptions by several anesthesiologists involved in the claims were bronchospasm or some difficulty with ventilation [1]. These catastrophic incidents should highlight the importance of preoperative clinical and radiographic evaluation, and of communication with the primary and surgical colleagues in devising a management plan for pediatric patients with anterior mediastinal mass.

In 1990, Ferrari and Bedford reviewed a total of 163 consecutive patients, aged 18 years or younger, with a diagnosis of anterior mediastinal mass as a component of their disease, who were admitted to Memorial Sloan-Kettering Cancer Center over a 6-year period [2]. Of these patients, 44 required general anesthesia. Anesthesia management consisted of intravenous or inhalational induction with the patients placed in the supine, semi-Fowler, or sitting position. In most children, the airway was secured with an endotracheal tube, and they were kept either spontaneously breathing or received positive pressure ventilation with or without muscle relaxant. A surgeon and a rigid bronchoscope were readily available in the operating room in case of sudden tracheal compression. There was no anesthesia death or sustained permanent injury. However, the investigators found several episodes of cardiorespiratory compromise [2]. It is important to note that the two patients in that retrospective chart review who presented with preoperative signs and symptoms of respiratory compromise developed complete airway obstruction after administration of muscle relaxant.

In this issue of the *Journal of Clinical Anesthesia*, Stricker et al. summarize their 8 years of experience at Children's Hospital of Philadelphia with 45 children with anterior mediastinal mass who underwent diagnostic and surgical procedures requiring anesthesia [3]. They classified patients based on their preoperative signs and symptoms and radiological findings. For patients with both preoperative symptoms suggestive of cardiopulmonary compromise and radiologic evidence of respiratory and cardiovascular compression (26), anesthetic management in 17 cases consisted of sedation with a natural airway and spontaneous ventilation. Although there were complications associated with the anesthetic, they were easily corrected and without long-term sequelae. Among those who received general anesthesia with endotracheal intubation with muscle relaxant, one patient suffered an episode of wheezing; the hypoxemia was resolved with a bronchodilator. For those who had greater than 50% tracheal compression and cardiopulmonary compromise, the anesthetic approach was sedation, a natural airway with spontaneous breathing, and supine or semi-Fowler positioning; no complications occurred.

Almost two decades have passed between the Ferrari and Bedford and Stricker et al. studies. The severe complications related to children with anterior mediastinal mass undergoing general anesthesia have decreased, as documented by Stricker et al. This decrease in the major adverse events associated with anesthetic management of pediatric patients with anterior mediastinal mass is not simply a perception. According to the ASA Closed Claims Project database, there were only 5 claims involving pediatric patients with mediastinal mass, and all occurred in the 1980s. A search of the current ASA Closed Claim Project database (claims collected through December 2008) representing events that occurred in 2000–2007, indicated no claim that involved a mediastinal mass.

The reasons for the decrease in adverse events associated with anesthetic management of pediatric patients with anterior mediastinal mass most likely involve the increased awareness

by primary care providers, surgeons, and anesthesiologists of the extensive involvement of anterior mediastinal mass. Emphasis on additional pulmonary and cardiology work-up prior to subjecting the pediatric patient with anterior mediastinal mass to anesthesia, use of the sitting or lateral decubitus position depending on the location of the mass, maintaining spontaneous breathing, and avoidance of muscle relaxant by the pediatric anesthesiologists also may have contributed to this decrease. Finally, the anterior mediastinal mass algorithm by experienced pediatric anesthesiologists for the patient so afflicted, certainly provides a guide for the anesthesiologist [4,5].

While we are delighted to learn that the major respiratory and cardiovascular catastrophes have been minimized over the last two decades, we should not underestimate the nature and involvement of anterior mediastinal mass even in the asymptomatic child, which may still lead to respiratory and cardiovascular compromise at any point during the anesthetic. According to Cheung and Lerman, “a clear understanding of the pathophysiology of these masses, together with a thorough history and physical examinations, are essential to minimizing the risk of perioperative complications” [5]. Overall, pediatric patients with anterior mediastinal mass should have an extensive work-up and every specialty involved in caring for

these pediatric patients should communicate with one another in advance, allowing for the proposed procedure to be modified to accommodate the anesthesia management.

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References

- [1] Narang S, Harte B, Body SC. Anesthesia for patients with a mediastinal mass. *Anesthesiol Clin North America* 2001;19:559-79.
- [2] Ferrari LR, Bedford RF. General anesthesia prior to treatment of anterior mediastinal masses in pediatric cancer patients. *Anesthesiology* 1990;72:991-5.
- [3] Stricker PA, Gumancy HG, Litman RS. Anesthetic management of children with an anterior mediastinal mass. *J Clin Anesth* 2010;22:159-63.
- [4] Lerman J. Anterior mediastinal masses in children. *Semin Anesth Perioper Med Pain* 2007;26:133-40.
- [5] Cheung SL, Lerman J. Mediastinal masses and anesthesia in children. *Anesthesiol Clin North America* 1998;16:893-910.

Dexmedetomidine for anesthetic management of anterior mediastinal mass

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Abstract Anesthetic management of anterior mediastinal masses (AMM) is challenging. We describe the successful anesthetic management of two patients with AMM in which dexmedetomidine was used at supra-sedative doses. Our first case was a 41-year-old man who presented with a 10 × 9 × 11 cm AMM, a pericardial effusion, compression of the right atrium, and superior vena cava syndrome. He had severe obstruction of the right mainstem bronchus, distal trachea with tumor compression, and endobronchial tumor invasion. Our second case was a 62-year-old man with tracheal and bronchial obstruction secondary to a recurrent non-small-cell lung cancer mediastinal mass. Both patients were scheduled for laser tumor debulking and

treatment of the tracheal compression with a Y-stent placed through a rigid bronchoscope. Both patients were fiberoptically intubated awake under sedation using a dexmedetomidine infusion, followed by general anesthesia (mainly using higher doses of dexmedetomidine), thus maintaining spontaneous ventilation and avoiding muscle relaxation during a very stimulating procedure. The amnestic and analgesic properties of dexmedetomidine were particularly helpful. Maintaining spontaneous ventilation with dexmedetomidine as almost the sole anesthetic could be very advantageous and may reduce the risk of complete airway obstruction in the anesthetic management of AMMs.

Keywords Mediastinal mass · Dexmedetomidine · Airway management

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Introduction

The anatomical position of an anterior mediastinal mass within the thorax can predispose patients to severe respiratory and/or cardiovascular complications during anesthesia. These may include airway obstruction, compression of cardiac chambers, and/or compression of the pulmonary artery. We describe the successful anesthetic management of two patients with anterior mediastinal masses (AMMs) in which spontaneous ventilation was achieved with minimum respiratory depression by using dexmedetomidine at supra-sedative doses.

Case 1

The patient was a 41-year-old man with synovial cell carcinoma of the left lower leg complicated by pulmonary

metastasis. He had previously undergone a right upper lobe (RUL) resection, a left lower lobectomy, and chemotherapy. As his disease progressed he developed a $10 \times 9 \times 11$ cm AMM (Fig. 1a, b), a pericardial effusion, multiple deep venous thromboses, pulmonary emboli, chronic airway obstruction, compression of the right atrium, and superior vena cava syndrome. He had severe obstruction of the right mainstem bronchus with tumor compression from the residual RUL. There was also extrinsic compression of the distal trachea and endobronchial tumor invasion of the remaining right lung, so he was ventilating from the left upper lobe and lingula only. The patient was very symptomatic, being short of breath with minimum activity, and his functionality was severely affected.

The plan was laser debulking of the tumor of the right lower and middle lobes and treatment of the compression with a Y-stent with a short left-sided limb.

Case 2

This patient was a 62-year-old man who initially presented a year before this procedure with shortness of breath and cough and was diagnosed with T4 N0 M0 tracheal cancer. He underwent initial laser debulking followed by chemotherapy (carbo-taxol), external beam radiation (5,940 cGy in 33 fractions), and brachytherapy application, with further brachytherapy 4 months later.

He remained well for two months when he noted progressively worsening shortness of breath, cough, hemoptysis, and wheezing. This led to a repeat CT scan (Fig. 2a, b), which demonstrated recurrence of the tracheal cancer with paratracheal mediastinal adenopathy. The tumor was judged to be unresectable locally and he was transferred to our tertiary care facility for further treatment. He was scheduled for bronchoscopic debulking and stenting.

Anesthetic management

Both patients were premedicated with 2 mg IV midazolam, followed by dexmedetomidine 1 mcg/kg IV infusion over 10 min as a loading dose and 0.6 mcg/kg/h to maintain sedation. The airway was topicalized with atomized lidocaine 4%. Following awake fiberoptic intubation with an 8.0 endotracheal tube (ETT), the dexmedetomidine infusion was gradually increased towards anesthetic levels (up to five times the maximum recommended dose for sedation; 0.2–0.7 mcg/kg/h). Small amounts of isoflurane (0.3%) for patient #1 and approximately 1.0% sevoflurane for patient #2 were also added. Adequate surgical anesthesia was assured by monitoring the patient's movements in response to surgical stimulation and by using a BIS[®] monitor (Aspect Medical, Newton, MA, USA) where the BIS index was maintained between 40 and 60. Both patients maintained spontaneous ventilation throughout, sustaining adequate oxygenation. No muscle relaxant was used. Intraoperative arterial blood gas analysis for the second patient during the early phase of his surgery while on 100% FiO₂ showed pH of 7.42, PaCO₂ of 44.3 mmHg, PaO₂ of 199 mmHg, BE of 4 mmol/L, sodium bicarbonate of 28.5 mmol/L, and O₂ saturation of 97%. The tumor was lasered via a flexible bronchoscope with the FIO₂ kept at approximately 30%. The ETT was then removed and a rigid bronchoscope was used for placement of the Y-stent and, in patient #2, further tumor debulking in a coring fashion using the barrel. Following successful stent placement, a tube exchanger was then introduced through the rigid bronchoscope and a 7.5 Parker ETT was railroaded over it after removal of the rigid bronchoscope. Our second patient had three episodes when his blood pressure fell from starting values of 120/60 mmHg to 80 s/50 s mmHg that was treated successfully with a bolus of 100 mcg of phenylephrine administered intravenously. On conclusion

Fig. 1 Patient # 1: **a** A volume-rendered 3D CT image in which the *black space* represents the mediastinal mass showing the effect on the airway. **b** CT showing the size of the calcified anterior mediastinal mass with lateral displacement and tracheal compression



Fig. 2 Patient # 2: **a** A volume-rendered 3D CT image showing the same (note what is left of the tracheal lumen after removal of the mediastinal mass from the image). **b** CT showing the size of the anterior mediastinal mass with tracheal compression (note the very small flattened tracheal lumen) and right main stem bronchus intrusion



of the procedure, the patients were transported to the post-anesthesia care unit (PACU) on a T-piece circuit supplied with 15 L/min of oxygen while breathing spontaneously. Both were extubated about 30 min after arriving in the PACU and reported no recall.

Discussion

We report the first successful use of dexmedetomidine as almost sole anesthetic without muscle relaxation in the management of a massive anterior mediastinal mass.

It has long been established that AMMs can precipitate serious, life-threatening respiratory and cardiovascular events [1]. The incidence of such complications in a pediatric population is approximately 7–20% intraoperatively and approximately 18% postoperatively [2–6]. Because these were observations made in a pediatric population, it is difficult to project this into the adult population [7]. However, extreme caution is advised in similar adult scenarios.

Airway obstruction is a very real and dangerous complication of general anesthesia in patients with an AMM. Three reasons have been given for this [8]. First, lung volumes can be reduced to 0.5–1.0 L, reducing oxygen stores. Second, general anesthesia relaxes airway smooth muscle leading to increased compliance, thus making it more likely to collapse under the pressure of the tumor. Finally, loss of spontaneous diaphragm movement precipitates a decrease in transpleural pressure gradient leading to a decrease in airway diameter. These factors all facilitate tumor compression of the airway. If use of muscle relaxants is avoided, spontaneous ventilation counteracts these mechanisms and maintains the negative intra-pleural pressure. This has been highly recommended in the anesthetic management of AMM patients [9].

Intraoperative management can be extremely difficult in patients with an AMM; a number of different conservative anesthetic management plans have been suggested [10]. The patient should be intubated via awake fiberoptic techniques with sedation while in the least symptomatic position. Topical anesthesia and inhalational agents are both good adjunctive courses of action.

Sedation, as an anesthetic technique, was not an option in this case because of the need to use a rigid bronchoscope to insert the plastic Y-shaped stent for tracheobronchial support at the carinal level. We decided to proceed with awake intubation followed by general anesthesia using dexmedetomidine which, even at higher doses, allowed spontaneous ventilation.

Dexmedetomidine is a selective α_2 agonist with sedative, analgesic, amnestic [11], and antisialagogue properties [12] that maintain spontaneous respiration with minimum respiratory depression, making it quite suitable for such cases. It is administered intravenously, the preferred route for anesthetic delivery in bronchoscopic surgery. Patients under dexmedetomidine sedation are usually easy to arouse [13], a property we exploited during awake fiberoptic-assisted intubation [14].

To maintain adequate anesthesia during a very stimulating procedure we used a relatively large dose of dexmedetomidine (compared with the sedation dose range of 0.2–0.7 mcg/kg/h); this is considered to be an off-label use. Such a large dose, or even larger, up to ten times the maximum recommended sedation dose, has been reported by Ramsay et al. as sole anesthetic agent in the anesthetic management of complicated clinical challenges [15], albeit in different circumstances in less stimulating procedures, and mainly to avoid the use of supplemental oxygen that could have increased surgical risk. In addition, low concentrations of isoflurane in the first case and sevoflurane in the second case were used to complement the limited

amnesic properties of dexmedetomidine [11]. At this dose neither isoflurane nor sevoflurane induced sufficient muscle relaxation to adversely affect respiratory function. It should be noted that many authorities recommend the use of sevoflurane in preference to isoflurane in similar situations, because it is claimed to cause less airway irritation.

The same line of thinking appealed to Ramsay et al. [16] when they used an anesthetic composed of 5 mg midazolam, dexmedetomidine infusion (up to 10 mcg/kg/h), and 1.0% sevoflurane in the anesthetic management of tracheal stenosis. Similarly, Nafiu et al. [17] used dexmedetomidine infusion as a sedative for a patient with a mediastinal mass undergoing Chamberlin's procedure.

Clinicians intending to use dexmedetomidine must be aware of its side effects. Those few side effects which are an extension of its pharmacological actions have been reported to be increases in systemic and pulmonary vascular resistance and hypertension (induced by peripheral α -2B receptors) when high doses are infused rapidly. Also, hypotension, bradycardia, and decreased cardiac output are evident at concentrations twofold greater than the therapeutic level. We encountered some hypotension with our second patient that was successfully treated with a small dose of phenylephrine. Thus, vigilant monitoring is essential when high doses of dexmedetomidine are used.

It has been suggested that cardiopulmonary bypass be available on stand-by and that femoral vessel cannulation should be achieved prior to induction for cases with patients having a >50% reduction in airway diameter, as seen on a computed tomography scan [2, 10]. However, some have noted that even having bypass equipment on stand-by will not always ensure a good outcome [9]. Even with a bypass team on standby, it may take from 5 to 10 min for adequate oxygenation to be achieved after complete airway obstruction [18]. Although the patient is most likely to be resuscitated, there is a good chance of hypoxic neurological injury. This emphasizes the importance of utilizing an anesthetic plan that lessens the chances of the need for such a very invasive intervention.

We conclude that maintaining spontaneous ventilation with dexmedetomidine as almost the sole anesthetic could be very helpful and may reduce the risk of complete airway obstruction in the anesthetic management of an AMM.

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Conflict of interest statement Dr. Abdelmalak recently received a one time honorarium from Hospira, Inc.

References

1. Bittar D. Respiratory obstruction associated with induction of general anesthesia in a patient with mediastinal Hodgkin's disease. *Anesth Anal.* 1975;54:399–403.
2. Azizkhan RG, Dudgeon DL, Buck JR, Colombani PM, Yaster M, Nichols D, Civin C, Kramer SS, Haller JA Jr. Life-threatening airway obstruction as a complication to the management of mediastinal masses in children. *J Pediatr Surg.* 1985;20:816–22.
3. 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.
4. Piro AJ, Weiss DR, Hellman S. Mediastinal Hodgkin's disease: a possible danger for intubation anesthesia. Intubation danger in Hodgkin's disease. *Int J Radiat Oncol Biol Phys.* 1976;1:415–9.
5. Ferrari LR, Bedford RF. General anesthesia prior to treatment of anterior mediastinal masses in pediatric cancer patients. *Anesthesiology.* 1990;72:991–5.
6. Turoff RD, Gomez GA, Berjian R, Park JJ, Priore RL, Lawrence DD, Panahon A, Douglass HA Jr. 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.
7. Bechard P, Letourneau L, Lacasse Y, Cote D, Bussieres JS. Perioperative cardiorespiratory complications in adults with mediastinal mass: incidence and risk factors. *Anesthesiology.* 2004;100:826–34.
8. 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.
9. Slinger P, Karsli C. Management of the patient with a large anterior mediastinal mass: recurring myths. *Curr Opin Anaesthesiol.* 2007;20:1–3.
10. Goh MH, Liu XY, Goh YS. Anterior mediastinal masses: an anaesthetic challenge. *Anaesthesia.* 1999;54:670–4.
11. Ebert TJ, Hall JE, Barney JA, Uhrich TD, Colino MD. The effects of increasing plasma concentrations of dexmedetomidine in humans. *Anesthesiology.* 2000;93:382–94.
12. Scher CS, Gitlin MC. Dexmedetomidine and low-dose ketamine provide adequate sedation for awake fiberoptic intubation. *Can J Anaesth.* 2003;50:607–10.
13. Maze M. Pharmacology and Use of Alpha-2 agonists in Anesthesia. *European Society of Anesthesiologists Refresher Course.* 2003; 37–43.
14. Abdelmalak B, Makary L, Hoban J, Doyle DJ. Dexmedetomidine as sole sedative for awake intubation in management of the critical airway. *J Clin Anesth.* 2007;19:370–3.
15. Ramsay MA, Luterman DL. Dexmedetomidine as a total intravenous anesthetic agent. *Anesthesiology.* 2004;101:787–90.
16. Ramsay MA, Saha D, Hebel RF. Tracheal resection in the morbidly obese patient: the role of dexmedetomidine. *J Clin Anesth.* 2006;18:452–4.
17. Nafiu OO, Srinivasan A, Ravanbakht J, Wu B, Lau WC. Dexmedetomidine sedation in a patient with superior vena cava syndrome and extreme needle phobia. *J Cardiothorac Vasc Anesth.* 2008;22:581–3.
18. Tempe DK, Arya R, Dubey S, Khanna S, Tomar AS, Grover V, Nigam M, Makwane UK. Mediastinal mass resection: femoro-femoral cardiopulmonary bypass before induction of anesthesia in the management of airway obstruction. *J Cardiothorac Vasc Anesth.* 2001;15:233–6.



Original contribution

Anesthetic management of children with an anterior mediastinal mass

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Abstract

Study Objective: To review the anesthetic management and perioperative course of children with an anterior mediastinal mass.

Design: Retrospective review.

Setting: University-affiliated children's hospital.

Measurements: The records of 46 children presenting with an anterior mediastinal mass between October 1, 1998 and October 1, 2006 were studied. Preoperative symptoms, diagnostic imaging and physical examination findings, anesthetic techniques, and perioperative complications were recorded.

Main Results: Spontaneous ventilation was maintained in 21 of 46 cases. Five patients had mild intraoperative complications, including upper airway obstruction, mild oxyhemoglobin desaturation, wheezing, partial airway obstruction, and a pneumothorax after mediastinal mass biopsy. There were no serious complications or perioperative deaths.

Conclusions: Children with a symptomatic anterior mediastinal mass underwent general anesthesia without serious complications. Spontaneous ventilation was preferred for all patients with severe airway compression.

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1. Introduction

When a child with an anterior mediastinal mass requires general anesthesia for a diagnostic procedure, there is a risk of development of catastrophic airway compression and/or cardiovascular collapse [1–11]. Biopsy of extramediastinal sites using local anesthesia and mild sedation has been recommended in numerous reports [4,12–15]. However,

many children will require general anesthesia (GA) or deep levels of sedation for adequate tissue sampling.

An 8-year review of the anesthetic management and perioperative course of children with an anterior mediastinal mass, who presented for diagnostic or surgical intervention, was conducted. Our primary aim was to describe the anesthetic management of these children and to determine factors associated with complications.

2. Subjects and methods

After approval from the Institutional Review Board of the Stokes Research Institute of The Children's Hospital of

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Table 1 Perioperative variables

Dependent variables	Independent variables
Respiratory signs/symptoms: wheezing cough exertional dyspnea orthopnea stridor retractions	Intraoperative complications: airway obstruction hypoxemia hypotension unplanned endotracheal intubation unplanned change in position unplanned rigid bronchoscopy
Cardiovascular signs/symptoms: facial swelling/SVC syndrome chest pain syncope	
Imaging study (plain radiograph, CT, MRI, echocardiogram) results: presence and degree of tracheal/bronchial compression great vessel/cardiac compression	
Pretreatment with chemotherapy or radiation treatment	
Intraoperative management: anesthetic/sedative agents mode of ventilation positioning neuromuscular blockade	
Surgical procedure performed	
Final postoperative diagnosis	

SVC = superior vena cava, CT = computed tomography, MRI = magnetic resonance imaging.

Philadelphia, a computerized search of our automated electronic anesthesia recordkeeping system (CompuRecord, Phillips Healthcare, Bothell, WA, USA) for anterior mediastinal mass cases that occurred between January 1, 1998 and October 1, 2006 was conducted. The term “mediastinal” was searched, both in the diagnosis category as well as free text in the record. All possible inclusive charts were examined to determine eligibility, which included the presence of an anterior mediastinal mass as a new diagnosis. Children with previous anesthetic encounters with the same diagnosis were excluded from analysis. Eligible patient records were examined and, in addition to demographic characteristics, dependent and independent variables were recorded (Table 1).

2.1. Statistical analysis

Descriptive analysis was performed to evaluate the data. All continuous variables are reported as means \pm standard deviation. A logistic regression analysis of the independent variables was attempted to evaluate their association with preoperative findings.

3. Results

A total of 45 charts met the inclusion criteria. Lymphoma was the final diagnosis in the majority of the cases reviewed (Table 2). Of the 45 patients, 34 (76%) had preoperative

signs or symptoms suggestive of cardiopulmonary compromise (Table 3). Of the 34 patients with signs or symptoms suggesting cardiopulmonary compromise (hereafter referred to as “signs/symptoms”), 26 (76%) had radiologic evidence of respiratory or cardiovascular compression (Fig. 1). Muscle relaxant was avoided in 18 of these 26 patients (69%); anesthetic management consisted of sedation with spontaneous ventilation and a natural airway in 17 of these cases (94%).

There were three complications in this group of patients. One child developed mild hypotension after sedation with ketamine, which resolved with the onset of surgical stimulation. This patient was a two year-old boy with an undifferentiated neuroblastoma who underwent biopsy of a cervical mass. Preoperatively, he complained of cough and abdominal pain; preoperative imaging showed airway

Table 2 Tissue diagnosis of anterior mediastinal mass

Diagnosis	# of Patients
Lymphoma	28
Normal thymus	3
Foregut cyst	2
Lymphangioma	2
Neuroblastoma	2
Teratoma	2
Germ cell tumor	2
Lipoblastoma	1
Other	3

was intubated for a rigid bronchoscopy; he showed evidence of distal tracheal compression on bronchoscopy.

We cannot comment on the depth of sedation in these patients, as it was not documented in the electronic medical record. The general practice among our colleagues is to maintain minimal to moderate sedation for patients with significant airway compression. No patient required the use of a rigid bronchoscope to bypass airway obstruction.

A logistic regression analysis was not performed. We were unable to perform such an analysis due to the small number of mediastinal mass-related complications in the review.

4. Discussion

In this review no mortality and little morbidity occurred. Of the 5 complications noted, one was due to the surgical procedure. This patient had pneumothorax and hypoxemia, which resolved with placement of a chest tube. One patient had wheezing with increased peak inspiratory pressures and another had upper airway obstruction during deep sedation with spontaneous ventilation; it is unclear if these symptoms were related to mediastinal pathology. A brief occurrence of hypotension in another patient resolved with surgical stimulation. Finally, the patient with partial airway obstruction during inhalational induction did not have significant ventilatory compromise.

Recommendations for preoperative evaluation of children with an anterior mediastinal mass include assessment of compressive signs and symptoms from the anterior mediastinal mass, CT imaging, echocardiography, and pulmonary function testing to assess for dynamic airway compression [4]. While radiotherapy or corticosteroid treatment before biopsy may improve perioperative risk, they also may adversely impact diagnostic histological accuracy [16]. Patients with greater than 50% tracheal compression as shown on CT scan may be at high risk for airway complications and may benefit from preoperative irradiation and/or corticosteroid therapy if general anesthesia is required [17]. In this review, three patients had greater than 50% tracheal compression and were maintained with spontaneous ventilation. Four patients received preoperative corticosteroid treatment, while none received radiotherapy. Spontaneous ventilation with a natural airway was used in three of the 4 patients.

Absence of radiological evidence and/or clinical signs/symptoms does not necessarily imply absence of risk [9]. Of 30 patients with documented evidence of respiratory tree or cardiovascular compression, 4 were asymptomatic. Conversely, 8 patients had symptoms potentially referable to mass effect who had no radiologic evidence of respiratory or cardiovascular compression. This discordance between symptoms and mediastinal compression underscores the importance of using a combination of history, physical examination, and diagnostic imaging studies when making perioperative management decisions.

Due to the small sample size and the low number of complications, a cause-and-effect relationship between anesthetic technique and perioperative complications could not be shown. It was unclear if decisions to administer deep sedation or general anesthesia were based on the degree of airway compression evident on CT scan. Some complications may have been avoided in the patients in whom spontaneous ventilation was maintained throughout the anesthetic. Patient selection by oncology providers for procedures performed during anesthesia also may have influenced our experience.

Many questions remain unanswered regarding the evaluation and care of pediatric patients with anterior mediastinal masses. This diverse patient population is not amenable to study by randomized trial. Treatment algorithms based on existing data, however, can be validated in prospective observational studies. The clinicians appeared to incorporate the evolving body of knowledge regarding management of patients with anterior mediastinal mass into their practice, and the outcome continues to improve for these high-risk patients. While the data are encouraging, continued caution is warranted in the care of these patients.

References

- [1] Azizkhan RG, Dudgeon DL, Buck JR, et al. Life-threatening airway obstruction as a complication to the management of mediastinal masses in children. *J Pediatr Surg* 1985;20:816-22.
- [2] Bray RJ, Fernandes FJ. Mediastinal tumour causing airway obstruction in anaesthetised children. *Anaesthesia* 1982;37:571-5.
- [3] Ferrari LR, Bedford RF. General anesthesia prior to treatment of anterior mediastinal masses in pediatric cancer patients. *Anesthesiology* 1990;72:991-5.
- [4] Hammer GB. Anaesthetic management for the child with a mediastinal mass. *Paediatr Anaesth* 2004;14:95-7.
- [5] Keon TP. Death on induction of anesthesia for cervical node biopsy. *Anesthesiology* 1981;55:471-2.
- [6] Levin H, Bursztein S, Heifetz M. Cardiac arrest in a child with an anterior mediastinal mass. *Anesth Analg* 1985;64:1129-30.
- [7] Prakash UB, Abel MD, Hubmayr RD. Mediastinal mass and tracheal obstruction during general anesthesia. *Mayo Clin Proc* 1988;63:1004-11.
- [8] Shamberger RC. Preanesthetic evaluation of children with anterior mediastinal masses. *Semin Pediatr Surg* 1999;8:61-8.
- [9] Viswanathan S, Campbell CE, Cork RC. Asymptomatic undetected mediastinal mass: a death during ambulatory anesthesia. *J Clin Anesth* 1995;7:151-5.
- [10] Vas L, Naregal F, Naik V. Anaesthetic management of an infant with anterior mediastinal mass. *Paediatr Anaesth* 1999;9:439-43.
- [11] Todres ID, Reppert SM, Walker PF, Grillo HC. Management of critical airway obstruction in a child with a mediastinal tumor. *Anesthesiology* 1976;45:100-2.
- [12] Perger L, Lee E, Shamberger R. Management of children and adolescents with a critical airway due to compression by an anterior mediastinal mass. *J Pediatr Surg* 2008;43:1990-7.
- [13] Ricketts RR. Clinical management of anterior mediastinal tumors in children. *Semin Pediatr Surg* 2001;10:161-8.
- [14] Pullerits J, Holzman R. Anaesthesia for patients with mediastinal masses. *Can J Anaesth* 1989;36:681-8.

- [15] Neumann 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.
- [16] Loeffler JS, Leopold KA, Recht A, Weinstein HJ, Tarbell NJ. Emergency prebiopsy radiation for mediastinal masses: impact on subsequent pathologic diagnosis and outcome. *J Clin Oncol* 1986;4: 716-21.
- [17] Shamberger RC, Holzman RS, Griscom NT, Tarbell NJ, Weinstein HJ. CT quantitation 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.