Journal of Clinical Anesthesia (2010) **22**, 159–163

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Journal of Clinical Anesthesia

Original contribution

Anesthetic management of children with an anterior mediastinal mass

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Received 16 September 2008; revised 5 October 2009; accepted 13 October 2009

Keywords:
Anesthesia, pediatric;
Children;
Mediastinal mass

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 Octobber 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.

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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doi:10.1016/j.jclinane.2009.10.004

Table 1 Perioperative variables

Dependent variables	Independent variables
Respiratory signs/symptoms:	Intraoperative complications:
wheezing	airway obstruction
cough	hypoxemia
exertional dyspnea	hypotension
orthopnea	unplanned endotracheal intubation
stridor	unplanned change in position
retractions	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 ± 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

Table 3 Incidence of signs and symptoms in patients

Signs and symptoms:	Number of patients/Total
Cough	21/45
Dyspnea	12/45
Orthopnes	10/45
Wheezing	6/45
Unequal breath sounds	5/45
Facial swelling	3/45
Syncope	2/45
Palpitations	2/45
Lethargy	2/45
Chest or back pain	6/45
Weight loss	4/45

compression at the level of the carina as well as left jugular vein and carotid artery compression. Intraoperatively, he was kept spontaneously breathing with a natural airway while placed in the Semi-Fowler's position.

Another patient in this group had upper airway obstruction with desaturation to 85% during sedation with a natural airway, which was successfully treated with a jaw thrust. This patient was a 15 year-old girl with Hodgkin's lymphoma who underwent biopsy of a neck mass and bone marrow biopsy. She complained of orthopnea and had superior vena cava (SVC) syndrome preoperatively. Imaging studies showed rightward tracheal deviation and compression of the SVC and innominate vein. This patient was sedated in the supine position with a natural airway throughout the anesthetic.

The third patient with complications in this group was a 5 year-old girl with T-cell lymphoblastic lymphoma who underwent mediastinal mass biopsy. She experienced hypoxemia due to a pneumothorax that developed after the biopsy. Hypoxemia resolved with chest tube insertion. Preoperatively she complained of cough, wheeze, and orthopnea; distal tracheal compression was noted on computed tomographic (CT) scan. She was breathing spontaneously with a natural airway and placed in the sitting position throughout the anesthetic.

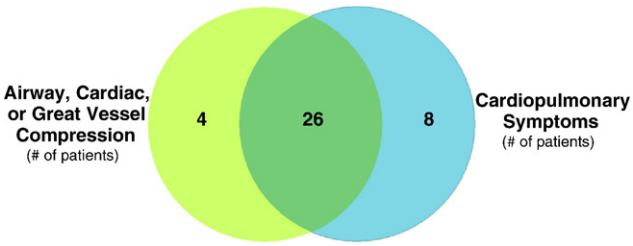

Fig. 1 Relationship between radiologic evidence of cardiorespiratory compression and the preoperative signs and symptoms suggestive of mass effect. Note the large overlap between the presence of physical signs or symptoms suggesting cardiorespiratory mass effect and radiologic confirmation of mass effect. Four patients with documented cardiovascular or respiratory tree compression were asymptomatic.

Eight of the 26 (31%) patients in the group with preoperative signs/symptoms and radiologic evidence of compressive mass effect received muscle relaxant and positive pressure ventilation (PPV). There was one complication in this group, which occurred in a 13 year-old girl with Hodgkin's lymphoma who underwent mediastinal mass biopsy and bone marrow biopsy. The patient complained of cough, wheezing, and orthopnea preoperatively, and she had mild SVC compression by the tumor with no tracheobronchial compression on CT scan. Muscle relaxants were administered after ability to deliver PPV was confirmed. She was anesthetized in the supine position and was tracheally intubated for the procedure. She had an episode of hypoxemia associated with intraoperative wheezing and increased peak inspiratory pressures that resolved with albuterol administration. She had been treated with corticosteroids prior to surgery.

Eleven patients presented without preoperative signs/symptoms. Four of these patients had radiologic evidence of respiratory tree or cardiovascular compression. There was one complication in this group. This patient was a 10 year-old boy with lymphangioma who underwent mediastinal mass biopsy. He had nonspecific complaints of lethargy and headache preoperatively; tracheal deviation was noted on preoperative chest radiography. This patient developed mild airway obstruction during inhaled induction of anesthesia that resolved. He was given muscle relaxant, his trachea was intubated, and he was placed supine throughout the procedure.

Three patients had radiologic evidence of greater than 50% tracheal compression (Table 4). All three children had preoperative signs/symptoms of cardiorespiratory compromise. Each of these patients received intravenous (IV) sedation with spontaneous ventilation and a natural airway; two of these children were kept in the Semi-Fowler's position for the procedure. No anesthetic complications were noted in these children. Three patients had radiological evidence of 20% to 50% tracheal compression. All had preoperative signs/symptoms of cardiorespiratory compromise. Two of these three patients received IV sedation with spontaneous ventilation and a natural airway. The third patient received a neuromuscular relaxant and his trachea

Table 4 Incidence of tracheobronchial and cardiovascular compression

Tracheal compression or deviation:	Number of patients/Total
Severe compression (>50%)	3/45
Moderate compression (20% to 50%)	3/45
Mild compression (0% to 20%)	12/45
No deviation/compression	27/45
Great vessel/cardiac compression: Present	24/45
Absent	21/45

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.

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