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Use of a sternal elevator to reverse complete airway obstruction secondary to anterior mediastinal mass in an anesthetized child

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ABSTRACT

Patients with an anterior mediastinal mass pose significant risk for cardiorespiratory compromise during surgical procedures and general anesthesia. Several techniques have been described to reverse airway obstruction in these patients. In extreme circumstances, patients may require cardiac bypass or extracorporeal membrane oxygenation (ECMO) until definitive treatment of the mass and patient stabilization is achieved. We present a case in which the RulTract® system was used for emergency sternal elevation as a bridge to ECMO in acute respiratory collapse in an 11-year-old female with a minimally symptomatic anterior mediastinal mass.

Patients with anterior mediastinal masses (AMMs) are high-risk for cardiorespiratory compromise due to airway and vascular compression [1–3]. Patients with AMMs vary in presentation, from a mild cough (most commonly) to severe airway compromise and/or superior vena cava syndrome [1,4]. In children and adolescents, an anesthetic is usually required to obtain tissue diagnosis, which may entail significant risk for more complicated cases. Several case reports and series have described acute cardiopulmonary decompensation upon induction of anesthesia or sedation in patients with tracheal compression from large AMMs [2,5–7]. A variety of techniques have been described to prevent morbidity and mortality associated with AMMs. Biopsy techniques under local anesthesia have been advocated for patients with signs and symptoms of airway compression [8,9], although patients have successfully undergone general anesthesia without incident in other cases [10]. Techniques for managing intraoperative complications from general anesthesia include lateral or prone positioning, rigid bronchoscopy, median sternotomy, and cardiac bypass or extracorporeal membrane oxygenation (ECMO) [6,7,9,11] although the latter techniques may take too much setup time to be feasible [12]. We present a case in which the RulTract® sternal elevator system provided a life-saving bridge to ECMO in a patient with external compression of the trachea from a large AMM.

1. Case report

An 11-year-old female initially presented with a several week history of facial swelling and intermittent right arm swelling. Over the prior weeks, she was seen by numerous other providers and was treated for presumed allergies with anti-histamines and ultimately steroids, which briefly alleviated her swelling. Her symptoms returned soon after, and she was again treated with a second round of steroids as well as an antibiotic. She was then referred to an otolaryngologist, dermatologist, and allergist and was eventually admitted to the hospital. Upon admission, workup included an echocardiogram, which revealed a 10 cm by 8 m complex cystic mass in the right anterior superior mediastinum with superior vena cava (SVC) compression. Computed Tomography confirmed these findings (Fig. 1).

Numerous enlarged lymph nodes in the neck and hilar region suggested lymphoma. Surgery was consulted to obtain tissue for diagnosis. Examination performed by the surgeon was difficult in palpating cervical lymph nodes due to some neck swelling, and

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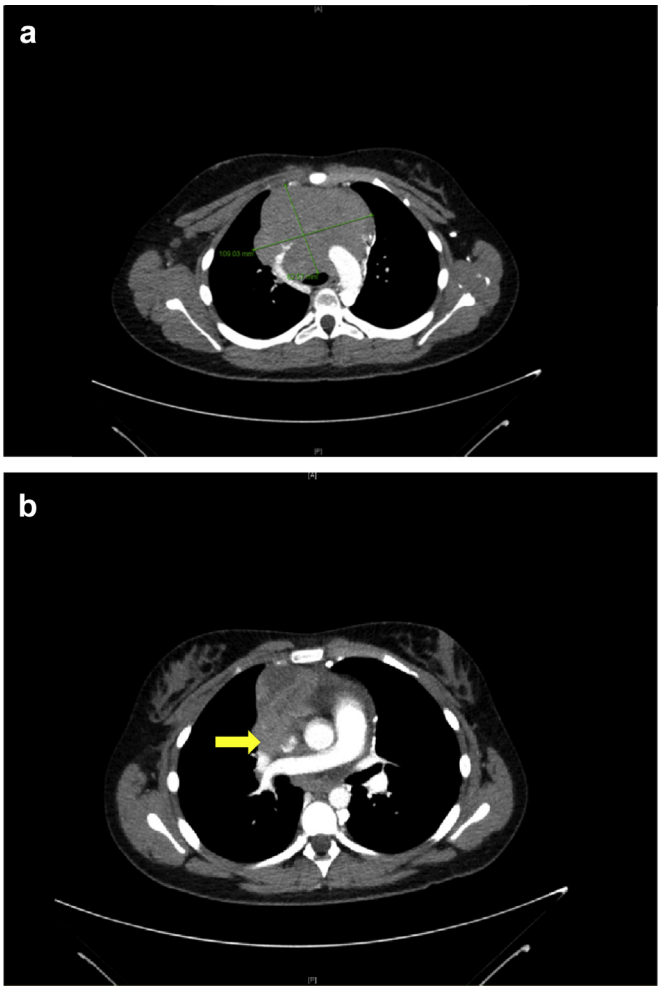

Fig 1. CT scan of the large mediastinal mass (a) and narrowing of the SVC (arrow) (b).

therefore surgical biopsy under a general anesthetic was felt to be most appropriate. The patient and family were consented for a biopsy of a deep right cervical lymph node, bilateral bone marrow biopsies and placement of a peripherally-inserted central catheter (PICC) to facilitate diagnosis and expedient therapy.

Preoperatively, the patient had no respiratory symptoms and was able to lie flat in bed. Chest X-ray (CXR) was not concerning for airway obstruction or tracheal deviation and CT imaging revealed tracheal area greater than 50% of predicted value. There was no jugular venous distention and vital signs were within normal limits. Both the surgery team and anesthesiologist reviewed the patient record, imaging and exam findings. While the patient was felt to be at risk of airway compromise, the anesthetic strategy included spontaneous ventilation to decrease tracheobronchial relaxation thus minimizing risk of collapse. With inhalation induction of anesthesia, partial airway obstruction was noted, but was relieved with positive airway pressure via mask. The trachea was intubated without the use of muscle relaxants, and positive airway pressure was used to augment spontaneous ventilation and relieve airway obstruction. Fiberoptic bronchoscopy was performed to evaluate the airway and confirmed near-complete airway collapse at the level of the carina that was stented open during positive pressure augmentation of spontaneous breaths. As she remained stable at this point, the biopsy of the deep right cervical lymph node was then performed. This was done without incident and intraoperative pathology consultation revealed findings to be most consistent with lymphoma.

Upon completion of the bone marrow biopsies and PICC placement and during emergence from anesthesia, the patient had complete airway obstruction and was unable to be ventilated. Potentially the airway collapse occurred due to a loss of positive pressure support during emergence, but no specific adverse event was identified as the cause of the airway collapse at the end of the procedure. The patient's immediate hypoxic state did not allow for time to perform noninvasive maneuvers such as repositioning of the patient or rigid bronchoscopy, and advancement of the endotracheal tube into the right mainstem bronchus did not relieve the obstruction. Given the severity and urgency of the situation, the decision was made to elevate the sternum to relieve the extrinsic compression on the trachea rather than turn the patient into the lateral or prone position. The patient's chest was immediately prepped and a stab incision just left lateral of the sternum was made. A bone hook was wedged into the sternum and the sternum was elevated manually, which allowed for immediate return of ventilation. With this temporizing measure, the chest was quickly prepped and draped, and the RulTract® retractor system with a bone-hook clamp inserted into the sternum was utilized for sustained elevation of the sternum (Fig. 2).

The patient was stabilized and successfully ventilated. During multi-disciplinary consultation involving cardiac surgery, pediatric surgery, pediatric intensive care, and pediatric anesthesia, various options were considered. Sternotomy with tumor debulking, prone positioning and leaving the RulTract® in place were discussed but felt to be inadequate options given the anticipated rapid response of the tumor size to chemotherapy and steroids. Ultimately, venoarterial ECMO was initiated as a means to oxygenate the patient while chemotherapy and steroids worked to decrease the tumor burden. ECMO was initiated via the femoral vessels as opposed to the neck vessels due to the patient's SVC obstruction.

Postoperatively, the patient was initiated on high-dose steroids and chemotherapy immediately given the pathologic diagnosis. ECMO was discontinued after three days and she was extubated after five days when there was a demonstrated decrease in tumor burden and resolution of airway obstruction (Fig. 3). Her postoperative course was complicated by a femoral thrombus from the ECMO cannula for which she required anticoagulation. She was successfully treated for lymphoma without other sequelae and remains in remission.

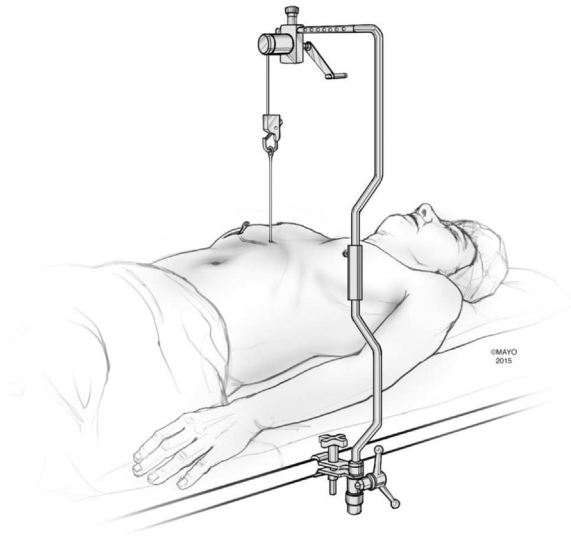

Fig 2. Illustration of the Rultract® sternal elevator in use.

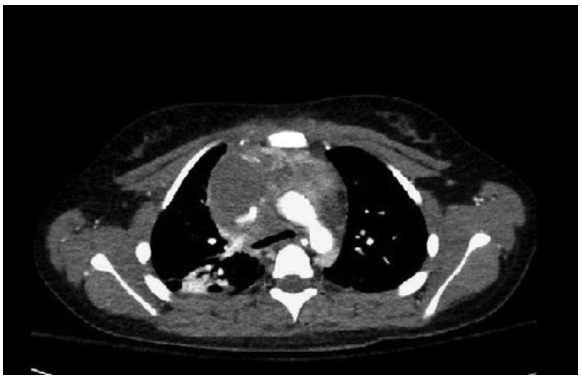

Fig 3. CT scan of the chest demonstrating decreased tumor size after response to chemotherapy and steroids.

2. Discussion

The majority of anterior mediastinal masses in children are lymphomas [9] which are generally responsive to chemotherapy. Tissue diagnosis is required to select appropriate chemotherapeutic agents, and pediatric surgeons are often employed asked to obtain tissue to direct therapy. Biopsy of a superficial lymph node under local anesthesia without general anesthesia has been advocated [9,10]. In this patient's situation, the difficult examination secondary to swelling may have complicated utilization of a percutaneous biopsy. Following this patient's case, others have been sent for percutaneous biopsy attempts first as a means of avoiding general anesthesia. General anesthesia can increase the risk of airway compromise because of the effects of supine positioning and relaxation of the tracheobronchial tree [8,13]. In instances where there are no easily accessible lymph nodes, it may be necessary to perform a biopsy of the mediastinal mass directly. Even in these situations, it is possible to perform mediastinal biopsy with use of local anesthesia [8]. However, if patients are too young or will not tolerate local anesthesia, general anesthesia may be employed, despite a greater risk to the airway. This patient was considered to be slightly less than high-risk during general anesthesia since the tracheal area was over 50% of predicted for the patient's size.

As this case illustrates, even patients with few or no examination findings of tracheobronchial compression can deteriorate upon induction of anesthesia. Emphasis should be placed on preoperative workup consisting of imaging such as CXR and CT assessing tracheal area as well as the use of flow-volume loops and pulmonary function testing (e.g. peak expiratory flow) to determine a patient's risk for significant events during general anesthesia. In this patient's situation, pulmonary function testing and flow-volume loops were not performed given the patient's clinical stability and examination and imaging findings although should have been considered more strongly. Pretreatment with radiation, steroids, or chemotherapy has been advocated to lessen the extrinsic tumor compression of the airway and great vessels [12]. It has been suggested that such treatment within 72 hours prior to biopsy has minimal effect on pathologic diagnosis [13]. However, most oncologists prefer tissue diagnosis prior to initiation of therapy which was also the case for this patient.

When unable to perform superficial lymph node biopsy under local anesthesia, these more invasive procedures should only be performed in an inpatient facility, with access to all possible treatment options including bronchoscopy, sternotomy and ECMO [12]. Prior to the induction of anesthesia, a thorough history and examination of the patient is mandatory, with focus on signs and symptoms of airway and venous obstruction. A chest CT establishes the location and degree of compression, and helps in the creation of a plan for anesthetic and surgical management. However, for this patient, tracheal compression and area on CT scan were felt to be adequate for attempting a general anesthetic. Prior to the induction of anesthesia, a plan for management of potential complications must be firmly established. Repositioning of the patient to a lateral, seated, or prone position may be of benefit [12]. Endotracheal intubation and/or rigid bronchoscopy may be attempted to alleviate compression of the trachea [5,12]. When these interventions are ineffective, sternotomy, cardiac bypass or ECMO, may be necessary. With this patient, turning the body would not have been efficient enough and rigid bronchoscopy was not readily available to the OR team and therefore, a temporizing measure was sought. Temporary relief of complete airway obstruction may allow the operative team time to implement one of these more definitive solutions. In the case presented, the use of a sternal bone hook and a RulTract® sternal elevator allowed ventilation of the patient until ECMO could be established.

The Rultract® skyhook surgical retractor is a device that is intended for hands-free retraction and exposure of surgical sites, and there are no currently listed contraindications for its use [14]. These and other similar retractors have been frequently used in the repair of pectus excavatum in adults and the pediatric population [15–18]. Other case reports have demonstrated a wide versatility of these types of retractors, including use in reconstruction of the abdominal wall [19], in sternal elevation for transcervical thymectomy [20,21], in thymic parathyroidectomy [22] and in minimally invasive repair of cardiac defects [19–23]. In the case presented, a bone hook and the RulTract® skyhook provided temporary relief of tracheal compression from a large AMM while the patient was prepared for ECMO. There are currently no other reports in the literature of the RulTract® being used for this purpose.

3. Conclusion

Patients with AMMs requiring invasive procedures provide a challenge for anesthesiologists and surgeons alike. Preoperative planning and testing is essential to effectively deal with possible complications. For acute airway compromise in the operating room secondary to AMMs or pathology, surgeons should consider use of a sternal elevator or another similar device as a temporizing measure to stabilize patients and provide a bridge to cardiac bypass, ECMO or sternotomy with or without tumor resection.

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References

[1] 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(6):816–22.
[2] Victory R, Casey W, Doherty P, Breatnach F. Cardiac and respiratory complications of mediastinal lymphomas. Anaesth Intensive Care 1993;21:366–9.
[3] Rath L, Gullahorn G, Connolly N, Pratt T, Boswell G, Cornelissen C. Anterior mediastinal mass biopsy and resection: anesthetic techniques and perioperative concerns. Semin Cardiothorac Vasc Anesth 2012;16(4):235–42.
[4] Ben-Ari J, Schonfeld T, Harlev E, Steinberg R, Yaniv I, Katz J, et al. Life-threatening airway obstruction secondary to mass in children–a preventable event? Pediatr Emerg Care 2005;21(7):427–30.
[5] Akhtar T, Ridley S, Best C. Unusual presentation of acute upper airway obstruction caused by an anterior mediastinal mass. Br J Anaesth 1991;67:632–4.
[6] Fabbro M, Patel PA, Ramakrishna H, Valentine E, Ochroch EA, Agoustides JG. Case 5—2014 challenging perioperative management of a massive anterior mediastinal mass in a symptomatic adult. J Cardiothorac Vasc Anesth 2014;28(3):819–25. http://dx.doi.org/10.1053/j.jvca.2013.12.029.
[7] Frey TKE, Chopra A, Lin RJ, Levy RJ, Gruber P, Rheingold SR, et al. A child with anterior mediastinal mass supported with veno-arterial extracorporeal

membrane oxygenation. Pediatr Crit Care Med 2006;7(5):479–81. http://dx.doi.org/10.1097/01.PCC.0000235247.10880.F8.
[8] Shamberger RC. Preanesthetic evaluation of children with anterior mediastinal masses. Semin Pediatr Surg 1999;8(2):61–8. http://dx.doi.org/10.1016/S1055-8586(99)70020-X.
[9] Garey C, Laituri C, Valusek P, St. Peter S, Snyder C. Management of anterior mediastinal masses in children. Eur J Pediatr Surg 2011;21:310–3.
[10] Perger L, Lee EY, Shamberger RC. Management of children and adolescents with a critical airway due to compression by an anterior mediastinal mass. J Pediatr Surg 2008;43(11):1990–7. http://dx.doi.org/10.1016/j.jpedsurg.2008.02.083.
[11] Sendasgupta C, Sengupta G, Ghosh K, Munshi A, Goswami A. Femoro-femoral cardiopulmonary bypass for the resection of an anterior mediastinal mass. Indian J Anesth 2010;54(6):565–8.
[12] Pearson JK, Tan GM. Pediatric anterior mediastinal mass: a review article. Semin Cardiothorac Vasc Anesth 2015;19(3):248–54. http://dx.doi.org/10.1177/1089253215578931.
[13] Robie D, Gursoy M, Pokorny W. Mediastinal tumors—airway obstruction and management. Semin Pediatr Surg 1994;3(4):259–66.
[14] RulTract instructions for use English, http://www.RulTract.net/Root/Instructions/EN/; 2008. Accessed 10.07.15.
[15] Jaroszewski DE, Johnson K, McMahon L, Notrica D. Sternal elevation before passing bars: a technique for improving visualization and facilitating minimally invasive pectus excavatum repair in adult patients. J Thorac Cardiovasc Surg 2014;147(3):1093–5. http://dx.doi.org/10.1016/j.jtcvs.2013.09.049.
[16] Johnson KN, Jaroszewski DE, Ewais M, Lackey JJ, McMahon L, Notrica DM. Hybrid technique for repair of recurrent pectus excavatum after failed open repair. Ann Thorac Surg 2015;99(6):1936–43. http://dx.doi.org/10.1016/j.athoracsur.2015.02.078.
[17] Johnson WR, Fedor D, Singhal S. A novel approach to eliminate cardiac perforation in the Nuss procedure. Ann Thorac Surg 2013;95(3):1109–11. http://dx.doi.org/10.1016/j.athoracsur.2012.10.016.
[18] Tedde ML, de Campos JRM, Wihlm J-M, Jatene FB. The Nuss procedure made safer: an effective and simple sternal elevation manoeuvre. Eur J Cardiothorac Surg 2012;42(5):890–1. http://dx.doi.org/10.1093/ejcts/ezs442.
[19] Bell EM, van Wingerden JJ. An ideal retractor system for reconstructive surgery of the abdominal wall: taking the weight off your assistant. Surgeon 2008;6(2):111–3.
[20] Ishikawa N, Sun YS, Nifong LW, Oda M, Ohta Y, Watanabe G, et al. A new retractor system for thoracoscopic thymectomy using the anterior chest wall-lifting method. Surg Endosc 2007;21(1):140–1. http://dx.doi.org/10.1007/s00464-005-0353-9.
[21] Komanapalli CB, Cohen JI, Sukumar MS. Video-assisted extended transcervical thymectomy. Innov Technol Tech Cardiothorac Vasc Surg 2007;2(2):90–4. http://dx.doi.org/10.1097/IMI.0b013e31803c9b45.
[22] Sukumar MS, Komanapalli CB, Cohen JI. Minimally invasive management of the mediastinal parathyroid adenoma. Laryngoscope 2006;116(3):482–7. http://dx.doi.org/10.1097/01.mlg.0000200582.65418.37.
[23] Levinson M, Fonger J. Minimally invasive atrial septal defect closure using the subxyphoid approach. Heart Surg Forum 1998;1(1):49–53.