Table #5

"When is an Inhaled Foreign Body Not Just an Inhaled Foreign Body?"

Moderators: Rajvinder S. Dhamrait, MD, FRCA, Sarah A. Maclean, MBChB

Institution: University of California Davis Children's Hospital, Sacramento, CA

Goals:

1. Discuss the differential diagnosis of stridor in a 8-month old child.
2. Describe the anesthetic management of a child undergoing removal of inhaled foreign body (F.B.).
3. Discuss the differential diagnosis of a child with increased work of breathing despite removal of inhaled F.B.
4. Describe the natural course, and clinical presentation of a Vascular Ring.
5. Discuss the perioperative management of this child undergoing thoracotomy for repair of Vascular Ring

Stem Case and Questions:

An 8-month old boy is brought to the Emergency Department (E.D.) by his parents with significant snoring and coughing. He weighs 9kg. He has a history of tracheomalacia, diagnosed at 2 months of age, and takes PRN albuterol. Prior to admission, he had had a cold and several bouts of vomiting. He was born at term, and is up to date with his immunizations.

Define stridor. Discuss the differential diagnosis of stridor in a child. What causes are more frequent in an infant with stridor? How does a child with inhaled F.B. present? What is the mortality rate associated with an inhaled F.B.

The child's initial vital signs are SpO_2 89% in room air, with respiratory rate 50/min and significant retractions and biphasic stridor. The E.D. staff is unable to secure peripheral intravenous access (P.I.V.). A C.X.R. is obtained. The child is becoming more agitated. He is transferred to the O.R. where you meet him.

How would you proceed? Discuss pre-medication in this child. What are your options for inducing anesthesia? How does the recent URI affect your choice of anesthetic?

The surgeon informs you that he wants tracheal intubation. The table will be turned 90^{o} away from the anesthetic machine. He asks how much local anesthetic he can use.

Does this information influence your anesthetic choice? Discuss the use of topical local anesthetic in this situation?

Once the anesthetic is induced, the table is turned and direct larynogoscopy proceeds. The surgeon inserts an appropriate bronchoscope and locates the foreign body.

How would you maintain anesthetic depth during bronchoscopy? Discuss the role of dexmedetomidine in this case. What are the iatrogenic complications associated with bronchosopy for removal of inhaled F.B?

The foreign body is safely removed and examination of the airway shows no residual foreign bodies and minimal edema of the bronchi. The patient is turned back to you.

What factors would influence your plan for emergence from anesthesia? Where would you place the child post-operatively?

Following emergence, the child continues to have stridor and shows signs of increased work of breathing.

What are the causes of post-extubation stridor? What would be your next step?

The patient does not improve despite your interventions. He is admitted to PICU. Over the next few days he undergoes further investigation which includes CT angiography. He is diagnosed with a Double Aortic Arch, and is scheduled for repair of this anomaly. You are his anesthesiologist again.

What is a double aortic arch? How is it diagnosed? What are the associated anomalies, if any?

The surgeon informs you that the patient will be in a lateral position, and the vascular anomaly will be repaired through a thoracotomy.

What is your anesthetic plan for this procedure? Is single lung ventilation required? What are your options for endobronchial intubation?

What are the options for analgesia?

The procedure is uneventful, and the patient airway is extubated at the end of the surgery. He returns to PICU, and eventually makes a full recovery.

Discussion

Stridor is noisy breathing caused by turbulent flow through the narrowed lumen of an airway, as a result of pathology. It can be monophasic or biphasic, with a typical inspiratory component signifying pathology above the level of the thoracic inlet. Causes can be divided into supraglottic, laryngeal and subglottic. Some causes are more common at certain ages.

Supraglottic causes include cysts, masses, laryngomalacia, hemangiomas, laryngoceles, papillomas and adenotonsillar hypertrophy, laryngotracheobronchitis and epiglottitis. Below the cords, causes include subglottic cysts, hemangiomas, foreign bodies and tracheomalacia. Tracheomalacia can be primary or secondary to external compression as with vascular rings. Subglottic stenosis (SGS) can be congenital or acquired from repeat or prolonged tracheal intubation.

In the neonate, the commonest cause is laryngomalacia, followed by vocal cord motion impairment (VCMI). Less common are SGS, laryngeal clefts, webs and tracheomalacia.

Anesthetic options for direct laryngoscopy and bronchoscopy include apneic oxygenation, ventilating bronchoscopy, jet ventilation, high frequency oscillation. The patient can be breathing spontaneously or have controlled ventilation; the airway can be secured with a tracheal tube or be unprotected. Morbidity associated with any technique does not appear to differ, and TIVA appears to offer a more stable depth of anesthesia compared to maintenance with a volatile agent.

Vascular rings constitute <1% of all congenital heart disease. This spectrum of disorders of the aortic arch (AA) results in compression of the trachea and esophagus. The commonest abnormality is the double aortic arch, first described in 1737, and making up 60% of all vascular rings. Other forms include (i) a right AA with aberrant left subclavian artery (SCA), and (ii) left AA with retroesophageal right SCA, amongst others. Partial rings or “slings” can also occur, for example, an aberrant right SCA passing behind the esophagus from an otherwise normal AA.

The double AA arrangement results from a persistent right dorsal aorta. This forms a right posterior AA, with the inominate arterial branch originating from it in 75% of cases, and a left anterior left AA with the left carotid and left SCA branches. Intra-cardiac associations are uncommon, but may include ventricular septal defects. 22q11 chromosomal deletions are seen in 20%. Tracheomalacia may be associated.

Signs and symptoms of increased work of breathing, and dysphagia usually develop within the first 6 months of life. Worsening dyspnoea on exertion or refractory asthma in an infant should heighten suspicion, but a missed finding may only present in a child who has acute esophageal foreign body impaction.

Investigations include C.X.R., which may show a right-sided AA, barium studies, C.T. angiography, M.R.I., and echocardiography. The latter test is to exclude intra-cardiac lesions. Surgical treatment is warranted if the symptoms are moderate to severe. Left untreated, tracheobronchial damage will occur. If intra-cardiac lesions exist, repair is performed through a median sternotomy, otherwise a thoracotomy approach is used. The vascular ring is divided, and the descending aorta can be suspended to rib or sternum periosteum to lift it away from the esophagus.

Anesthetic considerations include the age/weight of the patient as well as the degree of tracheal collapse. On induction, airway collapse may be complete so consideration for an inhalation induction should be given. Tracheal tube size is also impacted by the degree of tracheomalacia. Patient positioning will be determined by the approach as stated above. Aberrant SCAs will preclude ipsilateral arterial cannulation since these aberrant arteries will be divided during the surgery, and postoperative intubation and ventilation may be needed to facilitate airway toilet.

Analgesia for thoracotomy or sternotomy includes intravenous, regional, neuraxial and local routes. Pain occurs with the thoracotomy approach from lung retraction, resection, fracture, dislocation of costovertebral joints, nerve damage, and parietal pleural irritation. Gabapentin may have a role to play in the multimodal approach to analgesia.

References:

1. Eastwood PR, Platt PR, Shepherd K *et al.* "Collapsibility of the Upper Airway at Different Concentrations of Propofol Anesthesia." *Anesthesiology* 2005; 103: 470-7.
2. Mahmoud M, Radharkrishman R, Gunter J *et al.* "Effect of increasing depth of dexmedetomidine anesthesia on Upper Airway morphology in Children." *Pediatric Anesthesia* 2004; 20(6): 506-515.
3. Chen LH *et al*. "The risk factors for hypoxemia in children younger than 5 years old undergoing rigid bronchoscopy for foreign body removal." *Anesth Analg* 2009; 109(4): 1079-84.
4. Zur KB, Litman RS. "Pediatric airway foreign body retrieval: surgical and anesthetic perspectives." *Pediatric Anesthesia* 2009; 19 (Suppl. 1): 109-117.
5. Farrell PT. "Rigid bronchoscopy for foreign body removal: anesthesia and ventilation." *Pediatric Anesth* 2004; 14(1): 84-9.
6. Fidkowski CW, Zheng H, Firth PG. "The Anesthetic Considerations of Tracheobronchial Foreign Bodies in Children: A Literature Review of 12, 979 cases." *Anesth Analg* 2010; 111(4):1016-1025.
7. Gerner P. "Post-Thoracotomy Pain Management Problems." *Anesthesiol Clin* 2008; 26(2): 355-vii.
8. Hughes R, Gao F. "Pain control for thoracotomy." *CEACCP* 2005; 5(2): 56-60.
9. El-Morsy GZ *et al*. "Can thoracic paravertebral block replace thoracic epidural block in pediatric cardiac surgery? A randomized blinded study." *Annals Card Anaes* 2012; 15 (4): 259-263.
10. Suh YJ *et al.* "Clinical Course of vascular rings and risk factors associated with mortality." *Korean Circ J* 2012; 42(4): 252-8.