AIRWAY FOREIGN BODY

Surgical Specialty:	Otolaryngology
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Background:

- General Considerations
  - Foreign body (FB) aspiration in children is a potentially life-threatening event that may result from the aspiration of food or other household items.
  - Foods with oils (such as un-roasted nuts) may lead to significant inflammation at the site where the FB is lodged.
  - Foods may also absorb moisture and break into smaller pieces, rendering extraction more difficult.
  - FBs containing wax or similar materials (such as crayons) may "melt", and conform to the shape of the airway.
  - FBs may be jagged and can puncture the airway or become wedged, making extraction difficult.
  - Partial airway obstruction may result in a "ball-valve" effect, leading to air trapping in the affected lung.
  - FBs in place for prolonged periods can lead to accumulated purulent material. This may contaminate the contralateral lung once the FB is removed.
- Patient Considerations
  - Removal of airway FBs are frequently scheduled as urgent cases to extract the FB before the patient decompensates. Occasionally, they may present as an airway emergency.
  - Patients are frequently full stomach.[1-7]
- Associated Comorbidities/Syndromes
  - No specific associated comorbidities/syndromes.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - A detailed history of the onset and severity of symptoms should be elicited.
  - Physical examination should focus on:
    - General appearance of the patient.
      - Work of breathing, presence and degree of respiratory distress
    - Airway evaluation to identify barriers to mask ventilation/intubation
    - Pulmonary auscultation to evaluate for signs of wheezing, stridor, or air trapping.
  - Additional labs/tests indicated during work-up
    - A chest x-ray (CXR) may help identify a radio-opaque FB and its location. Other CXR findings include lung hyperinflation and mediastinal shift away from the affected lung.

- Discussions to have with surgeon/family
  - Risks/benefits/alternatives to proceeding with parents and surgeon
    - Proceeding with an open-airway case despite a full stomach can predispose to further aspiration of gastric contents.
  - Code status
  - ECMO candidacy
- Specific or Unique Room Set-Up Requirements
  - Airway
    - Consider risks/benefits/alternatives of open airway vs. rapid sequence induction (RSI)
    - RSI may protect against additional aspiration, but the presence of an endotracheal tube (ETT) hinders rigid bronchoscopy and may prevent successful FB extraction
      - ETTs smaller than 4.0 may not be large enough to allow the passage of a bronchoscope.
      - Tracheal extubation may be required at the time of FB removal if the FB cannot pass through the ETT.
        - The patient may be reintubated for emergence from anesthesia after the FB is removed from the airway.
    - Open airway with the maintenance of spontaneous ventilation is frequently used.
      - A 4.0-5.0 uncuffed ETT in the side of mouth allows delivery of oxygen and volatile anesthetic while the surgeon is working.
      - Some rigid bronchoscopes have ventilating ports which may be connected to the anesthesia circuit.
      - An ETT universal adaptor may be connected to a nasal airway and used to insufflate oxygen and volatile anesthetic.
      - The use of IV anesthetic agents such as propofol allows for more reliable delivery of anesthetic agent, and less contamination of the operating room(OR) with inhaled anesthetic agents.
    - Be prepared to intubate emergently if reflux of gastric contents is identified.
  - Drugs/Infusions
    - Local Anesthetic
      - 1-2 mg/kg lidocaine delivered via laryngeal tracheal atomizer (LTA) may decrease the response to laryngoscopy and bronchoscopy
    - Steroids
      - Dexamethasone (0.2-1mg/kg) -Max 20mg
        - Higher doses may be indicated for traumatic extraction.
    - PONV Prophylaxis
      - Ondansetron (0.1-0.15mg/kg) -max 4mg
    - Emergence Delirium Prophylaxis
      - Dexmedetomidine (0.5mcg/kg)
    - Many options/combinations for maintenance and institutional practices vary.
      - Sevoflurane
        - Delivery may be inconsistent during open airway cases
        - Volatile is vented directly into the OR.
      - Dexmedetomidine
        - Bolus (0.5-1mcg/kg) or infusion (0.2-1mcg/kg/h)
      - Ketamine
        - 0.5-1mg/kg boluses
      - Remifentanil
        - 0.05-2mcg/kg/min infusion

        - Propofol
            - 100-300 mcg/kg/min infusion titrated to effect
    - Monitors
        - Standard ASA monitors
        - $EtCO_2$ unreliable during open airway
            - SpO_2 and chest movement must be observed to confirm oxygenation and ventilation
    - Blood Availability (if indicated)
        - Usually not required
    - PICU Bed Availability (if indicated)
        - May be needed in case of prolonged procedure leading to airway edema, aspiration, pneumothorax or significant respiratory distress in the postoperative period.
    - Other Indicated Resources
        - ECMO standby may be indicated if the FB has a high likelihood of completely obstructing the airway or if there is concern that contamination of the contralateral lung may occur, leading to respiratory collapse.

Intraoperative Considerations:

- General
    - Laryngoscopy is VERY stimulating, and the anesthetic depth should be deep enough to tolerate this.
        - Subsequent removal of stimulation may lead to deep anesthesia and apnea.
    - Maintenance of spontaneous ventilation is the goal during open airway cases.
    - Role of apneic oxygenation.
        - Healthy patients can tolerate prolonged apnea if 100% O_2 is insufflated during bronchoscopy.
    - $PaCO_2$ will continue to rise in the absence of effective ventilation.
    - Possible tension pneumothorax if severe air trapping.
        - Have a plan for decompression.
- Induction
    - Consider risks/benefits/alternatives of an open airway with spontaneous ventilation vs. RSI and controlled ventilation.
    - Patients frequently don't have intravenous access preoperatively, and may require a mask induction with the maintenance of spontaneous ventilation.
- Positioning
    - Supine with bed turned 90°.
- Maintenance
    - Goal is the maintenance of adequate anesthetic depth to prevent bronchospasm and/or laryngospasm.
        - Drugs and agents as mentioned above.
- Hemodynamic/Physiologic goals
    - Adequate anesthetic depth to avoid coughing, bronchospasm, and laryngospasm.
    - Avoid aspiration
    - Maintain spontaneous ventilation for open airway cases.
- Surgical Considerations (such as neuromonitoring, muscle relaxation, anticipated blood loss)
    - If tissue is inflamed or the FB is wedged deep or fragmented, extraction may be prolonged.
        - Application of vasoconstricting agents (epinephrine, phenylephrine, oxymetazoline) via the bronchoscope may decrease edema and facilitate extraction.

    - Surgeon may manipulate the head or neck to align the airway so rigid bronchoscope may reach bronchus.
- Emergence/Disposition
    - Patients with full stomach may be intubated after FB removal and awakened in the OR prior to extubation.
    - Patients with significant airway trauma or edema may require PICU monitoring and possible post-op ventilation.
- Postoperative Care
    - While intra-op laryngoscopy is very stimulating, patients usually don't have much pain postoperatively.
    - Patients should be monitored for signs of airway edema while recovering
        - Treat aggressively with racemic epinephrine and be prepared to reintubate

Case-Specific Complications/Pitfalls

- Total airway obstruction
    - If the FB lodges in trachea, it may need to be pushed back into a mainstem bronchus.[5]
- Contralateral lung contamination
    - Removal of the FB may release purulent material accumulated behind it
        - This may contaminate the contralateral lung and lead to respiratory collapse.[6]
- Pulmonary hypertension
    - Both hypoxia and hypercarbia increase pulmonary vascular resistance (PVR).
        - Patients with pre-existing pulmonary hypertension or cardiac defects may not tolerate increases in PVR.
- Laryngospasm
    - May occur due to light anesthesia and/or surgical manipulation of vocal cords.
- Bronchospasm
    - Difficult to treat with an open airway.
    - Have a low threshold for administering small boluses of IV epinephrine.
- Stridor
    - Edema from surgical manipulation can cause obstruction
        - Generous steroid administration may help mitigate this.
        - Racemic epinephrine may be given to decrease edema.
        - Patients receiving racemic epinephrine may warrant prolonged observation in the PACU to monitor for rebound occurrence of stridor.
- Fistula formation
    - FBs can cause tracheoesophageal fistulae via mechanical pressure, puncture, or caustic trauma.
- Pulmonary hemorrhage
    - FB erosion into the pulmonary vasculature may result in catastrophic hemorrhage

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