INHALED FOREIGN BODY IN CHILDREN

BAPA
Refresher course
24th January 2015

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Epidemiology

- Common domestic accident (1.2% of admissions in Trousseau and 7.3% of bronchoscopy)
- Life threatening accident: 30 deaths/y in France, 300/y in USA
- Mortality rate up to 1.8%
- Most deaths occur at time of aspiration (complete upper airway obstruction)
Epidemiology

- Boys >> Girls (2:1)
- 1 to 3 year-old group
  - Put objects in their mouths
  - Less ability to chew
Epidemiology

- Nature of FB
  - <3 ans: Food! (up to 80%)
  - Older children: metallic or plastic objects

- Oilseed (nuts and seeds)
  - 1/3 of FB
  - Contact phenomenon with bronchial inflammation
  - « Peanut bronchitis »
n° 1 Public Enemy
ARTICLE ORIGINAL

L’épingle à foulard : un nouveau corps étranger intrabronchique

Scarf pin: A new intrabronchial foreign body

Presentation and diagnosis

- Site of FB within the airway
- Size and shape of FB
- Early vs late presentation

Severe acute upper airway obstruction

↓

Well pink child coughing

↓

No symptoms
Presentation and diagnosis

- « Index of suspicion »
  - Careful history
  - Examination
  - Special investigations
Clinical presentation

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Physical Examination Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choking</td>
<td>Stridor</td>
</tr>
<tr>
<td>Intractable cough</td>
<td>Wheeze</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>Diminished breath sounds</td>
</tr>
<tr>
<td>Fever</td>
<td>Tachypnea</td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>Muscle retractions</td>
</tr>
<tr>
<td>Nasal flaring</td>
<td>Grunting</td>
</tr>
</tbody>
</table>

Table 1  Symptoms and Physical Examination Findings in Patients with Airway Foreign Body Aspiration

Karen L. Swanson, Seminars in respiratory and critical care medicine 2004
Clinical presentation

« penetration syndrome »

- Sudden onset of choking
- Intractable cough
- With or without vomiting

- Variable intensity
- Is not always witnessed
Localisation of FB

Right main bronchus
Clinical presentation: Time

Undetected FB syndrome
FB remains lodged in the tracheobronchial tree

- Chronic pulmonary infections
- Allergic Asthma
- Lung abscess
- Bronchiectasic changes

The severity of pulmonary changes are correlated with duration of symptoms
Clinical presentation: Assess severity

- **MILD OBSTRUCTION**: Patient is able to
  - breathe
  - cough effectively
  - Speak

- Closely observe
  - Encourage to cough by themselves
  - No chest physiotherapy or interventions (back blows)

Risk of dislocating the FB and worsening the obstruction
Clinical presentation: Asses severity

- **Severe obstruction:**
  - Unable to breathe or speak
  - Wheezy breath sounds
  - Attemps at coughing are quiet or silent
  - Cyanosis and diminishing conscious level
  - Unconscious
Place the infant stomach-down across your forearm and give five quick, forceful blows on the infant’s back with heel of your hand.

**Mofenson maneuver**

Heimlich Maneuver

1. Lean the person forward slightly and stand behind him or her.
2. Make a fist with one hand.
3. Put your arms around the person and grasp your fist with your other hand near the top of the stomach, just below the center of the rib cage.
4. Make a quick, hard movement, inward and upward.

Remove the object with your finger **ONLY if you can see it**.
Whatever the presentation...

→ Transfer the child into a specialised center
IN-HOSPITAL MANAGEMENT
Special investigations

- Suggestive history / Clinical evaluation
- If the patient is stable:
  - Chest and neck Rx (inspirationexpiration)
    - Assess for other potential causes of symptoms
    - Identify a radio-opaque FB
    - Detect the position of a FB (indirect signs)
  - Thoracic computed tomography
Chest and Neck RX: direct signs

- = direct visualisation of a radio-opaque FB
- About 10% of FB
Chest and Neck RX : indirect signs

- **Hyperinflation** < air trapping behind the FB or obstructive emphysema
  - Best view : end expiration
  - ! Child cooperation...

- **Atelectasis**

- **Mediastinal shift**

- **Lobar collapse/consolidation**

- **No Rx abnormality (1/3), especially in the first 24h**

Fidkowski at al Anesthesia & Analgesia 2010
Imaging should never come before the management of an **unstable** child!
Management strategy

A positive history or clinical suspicion of FB inhalation must undergo endoscopy

Gold standard = Rigid Bronchoscopy

- Flexible bronchoscopy?
Rigid Bronchoscopy

- Metal tube
- Optical telescope
- Ventilation
- Aspiration

Fig. 1 A 20 cm, size 3 Storz bronchoscope (above) with Hopkins optical rod (below).

Roberts et al, Paediatric bronchoscopy, BJA 2005
Rigid Bronchoscopy

Figure 1. A rigid bronchoscope (top) has openings in the distal end to allow ventilation to the contralateral lung; a tracheoscope (bottom) lacks these holes.

Figure 2. The proximal part of rigid bronchoscope has multiple ports: The ones on the lower side are for ventilation; those on the upper side are for instrumentation.

Figure 3. A rod-lens telescope can be introduced into the rigid scope; a light source connects to inferior part of telescope. Visualization is done through the black port.
Rigid bronchoscopy
Rigid bronchoscopy
Clinicaly unstable child
laryngeal or tracheal FB
Bilateral FB

Removal = vital emergency

- In any other case, the procedure should be performed during normal day time to ensure optimal conditions (fasting, team, material)
- Because...
The Anesthetic Considerations of Tracheobronchial Foreign Bodies in Children: A Literature Review of 12,979 Cases

Christina W. Fidkowski, MD,* Hui Zheng, PhD,† and Paul G. Firth, MBChB*†

- Review article
- Medline keywords: foreign body aspiration between 2000 and 2009
- 30 articles
- 12,979 children (<18 years, with suspicion of FBi)
Rigid Bronchoscopy

- Life threatening procedure

### Major Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Total n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major nonfatal complications (n = 91)</td>
<td></td>
</tr>
<tr>
<td>Severe laryngeal edema or bronchospasm requiring tracheotomy or reintubation</td>
<td></td>
</tr>
<tr>
<td>Pneumothorax or pneumomediastinum</td>
<td></td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td></td>
</tr>
<tr>
<td>Hypoxic brain damage</td>
<td></td>
</tr>
<tr>
<td>Tracheal or bronchial laceration requiring repair</td>
<td></td>
</tr>
<tr>
<td>Other serious complications (n = 136)</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td></td>
</tr>
<tr>
<td>Failed bronchoscopy requiring thoracotomy (26)</td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td></td>
</tr>
<tr>
<td>Thoracotomy (3)</td>
<td></td>
</tr>
<tr>
<td>Tracheotomy (7)</td>
<td></td>
</tr>
</tbody>
</table>

Major iatrogenic complications, as were specified in 21 studies, occurred in 91 of the 9437 children with aspirated foreign bodies. Other serious complications occurred in 136 of these 9437 children.

### Deaths

<table>
<thead>
<tr>
<th>Cause of death (n = 43)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac/respiratory arrest</td>
<td>37</td>
</tr>
<tr>
<td>Hypoxic arrest at presentation</td>
<td>15</td>
</tr>
<tr>
<td>Arrest due to tracheal foreign body</td>
<td>5</td>
</tr>
<tr>
<td>Cardiac arrest during bronchoscopy, not specified</td>
<td>3</td>
</tr>
<tr>
<td>Postoperative arrest</td>
<td>3</td>
</tr>
<tr>
<td>Hypoxic arrest due to shifting foreign body</td>
<td>2</td>
</tr>
<tr>
<td>Respiratory arrest due to inhaled cement powder</td>
<td>1</td>
</tr>
<tr>
<td>Not specified</td>
<td>7</td>
</tr>
<tr>
<td>Bronchial rupture</td>
<td>2</td>
</tr>
<tr>
<td>Severe bronchospasm</td>
<td>1</td>
</tr>
<tr>
<td>Postoperative infection</td>
<td>1</td>
</tr>
<tr>
<td>Multiorgan failure</td>
<td>1</td>
</tr>
<tr>
<td>Not specified</td>
<td>1</td>
</tr>
</tbody>
</table>

Deaths, as were specified in 26 studies, occurred in 43 of the 10,236 children with aspirated foreign bodies.
Preparation

- Experienced senior medical staff
- Fully equipped procedure room
- Minimum 2 anesthetists
- One of whom paediatric anaesthetist
- Child fasted, ATB, steroids

= Optimal safety requirements
Anesthesia Management

Goals:

- Adequate anesthesia and analgesia
- Abolish the reflexes of the respiratory system

DEEP ANESTHESIA

- Conserve adequate gas exchange
- Rapid recovery of consciousness, spontaneous ventilation and cough reflex
Anesthesia Management

IN ANY CASES:

- General anesthesia
- Venous access
- Standard monitoring
- Topical anesthesia vocal cords (max 4mg/kg lidocaïne)
- FiO2 100%
- Never tolerate SpO2 < 90%
Anesthesia Management

- Induction
  - Inhaled or IV
  - Spontaneous vs controlled ventilation

- Maintain
  - Inhaled or IV
  - Spontaneous vs controlled ventilation
Anesthesia : Induction

- Child should be kept calm
- Venous access before induction (if possible)
- Respect the position of the child
- Induction keeping spontaneous ventilation (SV)
  - Inhalational Sevoflurane
  - Total IV
- IV or inhalational : no consensus
- Most pediatric anesthesiologists prefer inhaled induction

The conversion from *spontaneous negative pressure breathing* to *positive pressure breathing* risks disloging an unstable FB causing complete obstruction.
Induction : Fasting?

- Ideally, children should be fasted before procedure.
- Rapid sequence induction?
  - IV line not always present
  - Sellick not recommended
  - Loss of spontaneous breathing
- Aspiration risk is low in a well conducted anesthesia
  - Deep anesthesia! In spontaneous breathing
  - Bronchoscope introduction first
  - Then gastric aspiration

Warner MA et al, Anesthesiology 1999; 90 : 66-71
Induction : airway management

1. Topical anesthesia glottis
2. Direct laryngoscopy (FB removal – Magill)
3. Introduction of the bronchoscope
4. Anesthesia circuit is connected to the side port of the bronchoscope
5. Close communication and cooperation between bronchoscopist and anesthesiologist
Maintenance: IV or Inhaled?

- Inhaled anesthesia is more common
  - But:
    - Anesthesia depth is inconsistent (leaks/hypoventilation)
    - Pollution OR
- TIVA
  - Propofol 200 to 400 μg/kg/min
  - Remifentanil 0.05 to 0.2 μg/kg/min
- 1 study compared the 2 techniques:
  - TIVA: more body movements, breath holding, laryngospams
  - But: doses of IV propofol and remifentanyl were lower than recommended

Chen LH et al, Anesth Analg 2009
Maintenance: Spontaneous or controlled?

- No benefits between anesthetics techniques
- Often there is a shift in techniques according to the clinical situation or technical difficulties encountered
## Maintenance: VS ou VC ?

<table>
<thead>
<tr>
<th>Spontaneous breathing</th>
<th>Controlled ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>• ↓Risk of FB dislodgment</td>
<td>• Deep anesthesia</td>
</tr>
<tr>
<td>• Maintain ventilation</td>
<td>↑Cardiac depression</td>
</tr>
<tr>
<td>• ↓Risk of hyperinflation</td>
<td>↑Respiratory depression</td>
</tr>
<tr>
<td></td>
<td>• Hypercapnia</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Neuromuscular blockade</td>
</tr>
<tr>
<td></td>
<td>• PEEP and positive P</td>
</tr>
<tr>
<td></td>
<td>↑Oxygenation</td>
</tr>
<tr>
<td></td>
<td>↓Atelectasis</td>
</tr>
<tr>
<td></td>
<td>• Risk of FB dislodgment</td>
</tr>
<tr>
<td></td>
<td>↑Risk of complete obstruction</td>
</tr>
<tr>
<td></td>
<td>↑Removal difficulty</td>
</tr>
<tr>
<td></td>
<td>• Apnea during manipulations</td>
</tr>
<tr>
<td></td>
<td>• Hyperinflation and barotraumatisms</td>
</tr>
</tbody>
</table>
Prevent complications

1. Ask regularly the endoscopist to come up in the trachea
   - Correct hypercapnia
   - Decrease pulmonary pressure
2. If ventilation becomes inadequate: pull bronchoscope above the carina, take the optic tube out and assist ventilation
3. Cough or breath holding: come up in the trachea and deepen anest
Perioperative complications

- Following airway manipulation
  - Bronchospasm, hypoventilation, coughing,…
- Due to technique
  - Trauma to lips, teeth, tongue, Pneumothorax, pneumomediastinum, surgical emphysema
- Drop of FB during retrieval
  - Inspection of pharynx, laryngoscopy, intubation to push it back into the bronchus
  - If fragmented FB, Child on the ipsilateral side
- Cardiac arrest
Post operative care

- Recovery will depend on:
  - Clinical state
  - Evidence of inflammation
  - Pulmonary lesions
  - Duration of bronchoscopy
- IV Steroid (Dexamethasone 0.5mg/kg)
- Epinephrine Aerosol
- ATB
- Chest physiotherapy
Take home messages

1. FB inhalation is an important cause of death in infants. Many of them occur before arrival at the hospital.
2. A high index of suspicion is required in those without obvious diagnosis.
3. Rigid bronchoscopy is the gold standard for FB removal.
4. Expertise of personnel, clear clinical plans and familiarity with equipment is the key to success.
5. Although there is no consensus from the literature, inhaled induction that maintains spontaneous breathing is commonly practiced.
6. Common time for serious complication = extraction of FB.
Thanks for your attention!

Hmmm, Doc, why don't we just make peanuts radio-opaque? Then we won't worry about delayed diagnosis of FB as much.

This would be easy to see on Xray.