Update in Anaesthesia

Bronchoscopy for a foreign body in a child

Based in part on: Dix P. Bronchoscopy for a foreign body in a child. *Update in Anaesthesia* (2003): **17**: 20-21.

P Dix and V Pribul
Correspondence Email: pippadix@doctors.org.uk

Summary

1. The clinical effect of an inhaled foreign body depends where the foreign body becomes impacted – most small foreign bodies pass into the distal airway, but larger objects may become impacted in the supraglottic area to cause choking, or in the trachea to cause severe airway distress.

2. Children often inhale foodstuff such as peanuts – organic foreign bodies can cause airway oedema and hyperreactivity, which may be worsened by anaesthetic gases. Topical lignocaine to the airway assists smooth anaesthesia.

3. A foreign body may become impacted distally or exert a ball valve effect to allow inflation but not deflation. For this reason, you must maintain spontaneous ventilation, and allow rigid bronchoscopy prior to intubation.

P Dix
Consultant Anaesthetist

V Pribul,
Anaesthetic Registrar
Royal Devon and Exeter NHS Foundation Trust
Exeter
UK

INTRODUCTION

Inhalation of a foreign body (FB) is a potentially life threatening event, with boys in the age range 1 to 3 years most at risk. Clinical features of FB inhalation vary from acute upper airway obstruction to pneumonia due to distal airway collapse, depending on where the FB becomes impacted in the airway and when the child presents. This article will discuss common presentations of FB inhalation, and a suggested technique to remove the FB safely.

PATHOPHYSIOLOGY

The clinical features of inhaled FB depend on the size and nature of the FB, and where it becomes impacted in the airway. Resistance to gas flow in the airway is related to the fourth power of the radius, so a small reduction in airway radius in a child will result in a large increase in resistance to airflow. Inhalation of an organic FB may result in airway hyperreactivity and mucosal oedema. The occurrence of oedema in addition to the physical presence of the FB results in a rapid increase in airway resistance. Coupled with the high oxygen consumption of infants and small children, hypoxia may occur rapidly if the FB is lodged in a major airway.

PRESENTATION

Presentation may be acute in the case of a supraglottic FB or FB in a major airway, or more insidious if the FB is distal and presentation is delayed. The signs and symptoms depend on the position of the FB in the airway.

The history may help in the diagnosis, for example sudden onset of respiratory distress while playing with small objects. A child who is actively coughing after a witnessed choking event has a supraglottic FB and should be managed according to choking algorithms - encourage the child to cough to clear the obstruction, use alternating back blows and chest thrusts (abdominal thrusts in the older child), or standard CPR if the child becomes unconscious (see Figure 1 and Paediatric Resuscitation article p 265). It is essential to intervene early – children with untreated airway obstruction due to a supraglottic FB do not often survive to reach hospital.

Figure 1. *Back blows in a choking infant with a FB above the vocal cords*

The vocal cords are the narrowest part of the airway in the child - in the majority of children who inhale a FB and reach hospital, the FB has passed between the vocal cords to a distal main bronchus (usually right main bronchus). Occasionally, the FB becomes impacted in the larynx or in the trachea:

Signs and symptoms of laryngeal or tracheal obstruction:

- Cough
- Choking
- Respiratory distress
- Cyanosis, desaturation
- Stridor
- Tachypnoea.

Sign and symptoms due to obstruction of a main bronchus:

- Respiratory distress
- Tachypnoea
- Wheeze
- Absent breath sounds on the affected side.

If the FB is small and has lodged in a distal airway, there may be no clinical findings during the acute phase, even following a clear history of FB inhalation. Air trapping might be seen on a chest X-ray on expiratory films, due to a "ball valve effect". Initially an air bronchogram may be seen, with later evidence of atelectasis distal

to the obstruction. The child may present a few weeks later with chronic cough, chest infection, and signs of consolidation affecting one or more lobes.

Figure 2. *Hyperlucent appearance of the right lung on this expiratory chest Xray demonstrates air trapping from a foreign body lodged in the right main bronchus. Image reproduced with kind permission of the Department of Radiology, Virginia Commonwealth University Medical Center, from www.pedsradiology.com*

You should consider FB aspiration in every child presenting with cough or stridor. The differential diagnosis includes infective causes such as:

- Croup (viral infection – typical barking cough with stridor and respiratory distress as a late complication),
- Acute epiglottitis (*Haemophilus influenza* type B infection – causes supraglottic cellulitis with severe sore throat, fever, toxic, 'muffled voice' and drooling),
- Acute tracheitis (Staphylococcal infection – child toxic, unwell).

Peanut oil is particularly irritant to the airways and can cause local mucosal oedema as well as a chemical pneumonitis picture, which may be the only presenting factor. A FB in the upper part of the oesophagus (hypopharynx) may present with respiratory distress due to external compression of the trachea.

PREPARATION, INVESTIGATION AND EXAMINATION OF THE CHILD

To a large extent this will be dictated by the clinical condition of the child, and intervention should be planned carefully with the ENT surgeon (if available).

You should make a rapid assessment of the child. Pay particular attention to examination of the airway and chest. If the FB has impacted in the airway but is not causing complete obstruction, the clinical signs may help to localize the site of obstruction:

- Inspiratory stridor - glottic or supraglottic FB
- Expiratory wheeze - infraglottic FB.

Measure the oxygen saturation with a pulse oximeter and give high flow oxygen if required.

If the child is stable a chest Xray may be helpful in localising the FB, although the majority of FBs will not be radio-opaque. In the acute situation few other investigations are indicated.

The child should be starved according to the recommended guidelines, but careful judgement of clinical priorities is required in a child with acute respiratory distress. Consider anticholinergic premedication to decrease airway secretions (atropine 20mcg.kg^{-1} PO). This will also reduce the vagal tone and avoid bradycardia during airway instrumentation. Sedative premedication should not be used.

TYPES OF BRONCHOSCOPE

A rigid bronchoscope should be prepared, and the anaesthetist should be familiar with the equipment available locally.

Rigid bronchoscopy has several clear advantages:

- Complete airway control
- Better view of the bronchial tree
- Larger channels through which to pass instruments and withdraw FBs.

In older children, the rigid bronchoscope only allows limited access to the upper lobes and more distal airways.

Two types of rigid bronchoscope are available. The older Negus bronchoscope is the original rigid bronchoscope, and has a tapered shape.

The Stortz ventilating bronchoscope is the most commonly used rigid bronchoscope. It is available in a variety of sizes and lengths from 2.5mm internal diameter. It has a side port to which the anaesthetic breathing circuit can be attached to provide anaesthesia during airway examination (see Figure 2). This allows safe examination of all children, including neonates.

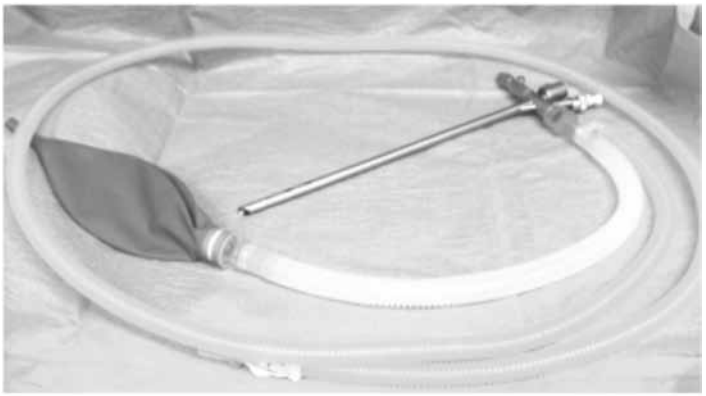

Figure 3. *Storz ventilating bronchoscope with anaesthetic T-piece attached*

The Hopkins rod lens telescope is inserted through the lumen of the bronchoscope, allowing a clear view of the endobronchial tree. A wide range of instruments including long grasping forceps are available to enable the FB to be retrieved (see Figure 3).

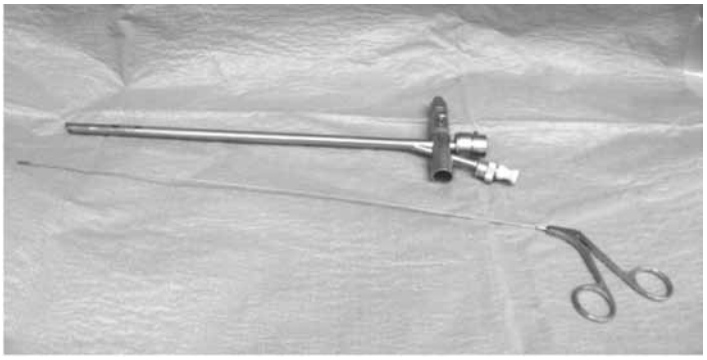

Figure 4. *Storz ventilating bronchoscope with long grasping forceps*

The anaesthetic T-piece circuit is attached to the sidearm of the bronchoscope to allow delivery of oxygen and anaesthetic gases during the procedure. The presence of the telescope, with the viewing end occluded, results in a closed system, through which either spontaneous or controlled ventilation may occur. When the telescope is removed the system is open, allowing only spontaneous ventilation, unless the operator occludes the port with their thumb. The telescope occupies a significant proportion of the bronchoscope through which expiration must occur. It may be necessary to remove the telescope periodically to allow adequate breathing through the lumen of the bronchoscope, especially when using smaller diameter bronchoscopes.

A Sanders injector can be attached to the sidearm to enable controlled ventilation, when the telescope is not being used. It uses the Venturi effect to entrain oxygen-enriched air. The entrainment of air means that it is not possible to deliver high oxygen concentrations, which may not maintain adequate patient oxygenation. Maintain anaesthesia with IV anaesthetic agents. In smaller children barotrauma can easily occur, so this is not the best technique for them.

ANAESTHESIA

Bronchoscopy is performed under general anaesthesia. The anaesthetic machine and other equipment should be checked, especially suction equipment. A range of sizes of tracheal tubes should be available, in case intubation is required urgently. Airway oedema reduces the tracheal diameter and a smaller tube than usual may be required – prepare a range of sizes.

Monitoring including pulse oximetry, ECG, non-invasive blood pressure, and capnography should be applied. Intravenous access should be secured prior to induction. If the child is distressed this can be performed immediately after induction.

A senior anaesthetist and ENT surgeon should be present at induction, along with the most skilled anaesthetic assistant available. Good communication between all members of staff is vital with an agreed plan for how the case will proceed. We recommend inhalational induction using either sevoflurane or halothane in 100% oxygen. There is much debate about the relative advantages of halothane and sevoflurane:

Advantages of sevoflurane:

- Less airway irritation
- Greater cardiovascular stability. Arrhythmias are a potential problem with halothane, and are worsened by of hypoxia, hypercapnia and high circulating levels of catecholamines
- More rapid onset.

Advantages of halothane:

- Longer lasting anaesthetic effect. This allows more time for airway manipulation without the child becoming too lightly anaesthetised and developing laryngospasm
- Often more readily available
- Lower cost.

The choice will be dictated by personal experience and preference, and also local availability. Ether is very slow in onset and difficult to use for inhalational induction, and is not recommended in this context.

The key to successful bronchoscopy is adminstration of topical local anaesthetic to the airway – this allows the surgeon to insert the bronchoscope and remove the FB without the child coughing. A safe dose of local anaesthetic must be used (4mg.kg^{-1} topical). Draw up the required dose into a syringe prior to the start of anaesthesia; attach a long cannula with the needle removed. This is used to apply the correct dose of local anaesthetic to the cords (see Figure 5)

Remember - 1% lignocaine contains 10mg.ml^{-1} lignocaine. The safe dose for a 8kg child is 3.2ml.

Figure 5. *Use of a cannula to administer topical lignocaine*

Spontaneous ventilation should be maintained if possible, although occasionally you might need to use gentle mask ventilation. Aggressive positive ventilation increases the risk of hyperinflation and pneumothorax if the FB is exerting a ball valve effect, allowing inflation but not expiration. Positive pressure ventilation is also likely to dislodge the FB distally. For this reason muscle relaxants are avoided.

After induction, site a cannula if it is not already in place, and discontinue nitrous oxide if used. Wait until the child is deeply anaesthetized before laryngoscopy. This can take a long time due to the reduced airflow. Apply topical lignocaine to the larynx and trachea as described above (maximum dose 4mg.kg^{-1}) – if possible apply the lignocaine to the cords and also between the cords. Rigid bronchoscopy can be performed after a few minutes.

During bronchoscopy, maintain anaesthesia by connecting a T-piece to the sidearm of the Stortz rigid bronchoscope. Do not intubate prior to rigid bronchoscopy, due to the risk of dislodging or fragmenting the FB possibly leading to complete airway obstruction. If the child desaturates during bronchoscopy of one lung, the bronchoscope can be withdrawn into the trachea to allow re-ventilation of both lungs, before a further attempt at bronchoscopy is made. The telescope might also need to be removed from the bronchoscope to allow adequate gas flow. Observe chest movements during bronchoscopy and monitor carefully at all times; the child may have little respiratory reserve and will desaturate very quickly. The bronchoscopist and anaesthetist must work closely together.

After removal of the FB the airway can be maintained using a face mask, tracheal tube or laryngeal mask, depending on the condition of the child. If the child has copious distal airway secretions, intubate and suction the airway, with gentle on-table physiotherapy if required.

Discontinue the anaesthetic, administer 100% oxygen, and observe the child carefully until awake and extubated. Address other symptoms at the same time, for example give IV fluids to counter dehydration.

Postoperatively, you must monitor the child for stridor and airway obstruction due to oedema. The child may have a sore throat, which can be managed with simple analgesia such as paracetamol and NSAIDs rather than opioids.

The child may need HDU care depending on their condition, particularly if presentation has been delayed. If the child has a secondary chest infection regular physiotherapy and antibiotics should be given (e.g. co-amoxiclav).

Humidified oxygen should be given for 24 hours if required, particularly if the child has low oxygen saturations and/or stridor. If worsening stridor occurs, nebulised adrenaline 1:1000 may be useful ($0.5ml.kg^{-1}$, maximum 5ml). Dexamethasone $250mcg.kg^{-1}$ IV at induction, followed by $100mcg.kg^{-1}$ 6 hourly for 24 hours has also been recommended.

LEARNING POINTS

1. The clinical effect of an inhaled foreign body depends where the foreign body becomes impacted – most small foreign bodies pass into the distal airway, but larger objects may become impacted in the supraglottic area to cause choking, or in the trachea to cause severe airway distress.
2. Children often inhale foodstuff such as peanuts – organic foreign bodies can cause airway oedema and hyperreactivity, which may be worsened by anaesthetic gases. Topical lignocaine to the airway assists smooth anaesthesia.
3. A foreign body may become impacted distally or exert a ball valve effect to allow inflation but not deflation. For this reason, you must maintain spontaneous ventilation, and allow rigid bronchoscopy prior to intubation.

CASE HISTORY

A 4 year-old boy presented to the emergency department with a history of coughing and choking while he was lying on his back playing with some coins. His mother reported that he went blue for a few seconds, and the child said that he had "swallowed" a coin.

On examination he was upset, but well. He was apyrexial, and had a respiratory rate of $20min^{-1}$ with no recessions. Chest auscultation revealed reduced breath sounds in the right lower lobe. A chest Xray showed a radio-opaque sphere in the area of the right main stem bronchus. Ametop local anaesthetic cream was applied to both hands.

The child was transferred to the operating theatre. The anaesthetic machine, suction equipment, and laryngoscopes were checked. The consultant ENT surgeon was present. A pulse oximeter and ECG leads were applied, and a 22G cannula was sited. Atropine $10mcg.kg^{-1}$ and dexamethasone $250mcg.kg^{-1}$ were given IV. Anaesthesia was induced using 3% halothane in oxygen breathed spontaneously via a face mask and Ayres T-piece circuit. After several minutes, when deep anaesthesia had been achieved, laryngoscopy was performed and the cords sprayed with 2mls of 4% lignocaine. A 3.5mm rigid bronchoscope was introduced into the trachea. The coin was retrieved uneventfully from the right main bronchus, and the bronchoscope was withdrawn from the airway. The halothane was discontinued, and the airway maintained with a face-mask until the child was fully awake.

Humidified oxygen was given overnight on the ward, and the child was monitored with pulse oximetry. The child was discharged home the next day.

REFERENCE

Dix P. Bronchoscopy for a foreign body in a child. *Update in Anaesthesia* (2003): 17: 20-21. Available from: http://www.wfsahq.org/components/com_virtual_library/media/b27816bcf8b61cce6fa0cc6a30571d56-424afcbfe58e46b3dc60622590113cad-Bronchoscopy-for-a-Foreign-Body-in-a-Child--Update-17-2003-.pdf