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Pediatric Rigid Bronchoscopy for Foreign Body Removal

Rigid bronchoscopy is a procedure that is performed in order to directly visualize the upper and lower airway and is carried out for either a diagnostic or therapeutic purpose. Suspected foreign body (FB) aspiration is the most common indication for performing this procedure in the pediatric age group at the Philippine Children's Medical Center where a recent census (May 2008 to April 2009) showed that of 21 cases where rigid bronchoscopy was performed, 10 were for suspected FB aspiration. A review of 101 cases in the same institution showed that the average age of patients with FB aspiration was 2 years and the most common item aspirated was a peanut followed by the *atis* (sweetsop) seed and chicken bone chips. The most common inorganic foreign body was an earring and "whistle" (which broke off from a toy).[1] It is more common in males probably because of their usually more active nature and is frequently found in the right mainstem bronchus where the FB more easily lodges - being straighter, shorter and wider in diameter. FBs are life-threatening events in children that require early diagnosis and prompt successful management.[2]

A good history, physical examination and analysis of diagnostic tests are vital in every situation. In most cases, the child's aspiration of the foreign object is a witnessed event [3] and this history of aspiration is the most sensitive diagnostic tool. The main symptoms include choking, prolonged cough and *dyspnea*. Abnormal physical examination findings are found in 67% to 80% of cases and include unilaterally decreased breath sounds, wheezing and stridor.[2,4] Radiographic procedures may show abnormal findings in only about 68-86% of cases.[4,5] The most useful radiographs requested are the chest posteroanterior (anteroposterior in infants and small children) and lateral views which may help localize the impaction site when the object aspirated is radiopaque.[3] However, most inhaled FBs are radiolucent and their presence can be suspected by obtaining inspiration and expiration views to demonstrate unilateral hyperinflation. Other suggestive features include atelectasis, pneumothorax and pneumonia. These indirect radiologic features of FB inhalation are present in 76% of cases.[2,] Where inspiration and expiration views cannot be obtained, as in very young children, left and right decubitus views may be helpful.[6] Fluoroscopic studies may also be obtained along with the plain radiographs, however, specificity and sensitivity are not very high.[4] Virtual bronchoscopy may also be used in patients with suspected FB aspiration. Virtual bronchoscopy which uses multislice computerized tomography (MDCT) with realistic 3-dimensional reconstruction may be helpful in detecting and localizing the FB prior

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to any surgical procedure and thus decreasing the number of patients needing diagnostic bronchoscopies.[7] Flexible fiberoptic bronchoscopy under local anesthesia and premedication may also be performed in cases of suspected FB aspiration wherein clinical and radiologic findings are not consistent with FB aspiration. When no FB is visualized, the patient is saved a rigid bronchoscopic procedure under general anesthesia.[8] Flexible fiberoptic bronchoscopy is also used therapeutically to remove FBs in the bronchus, however, successful removal is more common with rigid bronchoscopy.

All the necessary instruments needed for the procedure must be prepared. As much as possible two of each instrument are prepared: two bronchoscopes (one estimated from the age and size of the child and one smaller than that – just in case!), two suction devices (if one gets clogged up, the other one is ready) and two forceps. The peanut forceps is ideal, not only for peanuts but usually for other nuts as well. The alligator forceps is useful for relatively flat foreign bodies while the "jaw type" forceps appears to be useful for everything else.[9] The instruments are then tried, to check if they are in working order before commencement of anesthesia. This involves checking the transparency of the glass window plug, ensuring that the light source and the proximal prismatic light deflector are both illuminating and trying out all the forceps and suction tips. It is best to try the instruments on an object similar to what the child aspirated.[3] The surgical assistant, nurse and instruments are usually on the right (if the surgeon is right-handed) and anesthesiologist on the left. The suction and bronchoscope are then made ready. Knowledge of the anatomy of the tracheobronchial tree is imperative to be able to navigate through this area while looking for the FB.

The use of optical forceps with mounted rod-lens telescopes has made the removal of airway FBs simpler, quicker and safer. These new devices have led to decreased complication rates and fewer missed or incomplete FB removals. While access to FBs located in the distal small segmental bronchi especially in very young children may be limited with the use of optical forceps,[10] this can be overcome by removal of the connecting bridge to allow the optical forceps to be passed distal to the tip of the bronchoscope.

An anesthesiologist familiar with the procedure must be called in. It is very important to have discussed the case and the procedure with the anesthesiologist prior to the operation to minimize confusion and promote harmony. Most anesthesiologists have become at ease with giving intravenous general anesthesia which circumvents the use of potentially noxious gases. Assisted spontaneous ventilation can avoid the need for muscle relaxation and paralysis so that the wake-up time is shortened. Intravenous general anesthesia with propofol and assisted spontaneous ventilation is currently the frequently used anesthetic technique for rigid bronchoscopy although volatile agents and gases are still used.[11,12]

The patient is placed supine on the operating table. A shoulder roll is not required. After induction of anesthesia, the patient is hyperventilated to 100% oxygen saturation to take full advantage of operating time.[3] A topical anesthetic (lidocaine or tetracaine) is sprayed into the laryngeal area and distally into the trachea to lessen stimulus and pain, thus lowering the level of the anesthetic agent used and minimizing the possible occurrence of laryngospasm after the procedure.[12] The state of dentition is inspected and a tooth guard placed over the upper teeth. Although it is possible to do bronchoscopy directly without using a laryngoscope, it is more expedient to use the laryngoscope (with the left hand) to visualize the larynx.

The assistant (most likely the ORL resident but occasionally, a nurse) hands over the bronchoscope (to the right hand) without the glass window plug initially (because it may fog up or fall off) and the bronchoscope is inserted by looking through the bronchoscope as it passes through the larynx. Rotating the bronchoscope by 90^0 (with the axis of the lip in the anteroposterior axis of the glottis chink) is often useful for easier bronchoscopic insertion.[2] Never force the bronchoscope into the larynx. If there is difficulty, reposition the laryngoscope to better visualize the larynx. Where exposure of the larynx is adequate, inability to pass the bronchoscope may be due to the bronchoscope lip hitting a vocal fold instead of entering the glottic chink. Another possibility is that the bronchoscope is too large to fit through a narrowed subglottis. The laryngoscope is removed once the bronchoscope has been inserted and the anesthesiologist connects the anesthetic tube to the standard 15-mm adapter of the bronchoscope and the glass window plug is inserted. (This is again removed when the forceps is introduced or suctioning needed). A 0^o telescope of the appropriate size may be inserted at this time or even during the initial insertion of the bronchoscope.

The left hand is placed over the tooth guard and the thumb and index finger are used to support the bronchoscope being held in the right hand, much like a billiard cue. The left thumb lifts the bronchoscope off the tooth guard to enable the bronchoscope to be advanced without resistance. The bronchoscope is advanced slowly, always ensuring that the lumen is clearly in view and suctioning whenever needed. Once the carina is seen, the main bronchus, where the FB is likely to be located, is then entered. Turn the head to the left to enable passage into the right main bronchus and then to the right to enter the left main bronchus. Some degree of neck flexion can also be helpful in aligning the main bronchus. The bronchoscope is advanced until it is as near

as possible to the FB to allow accurate suction of secretions so that the surgeon can determine how best to orient the forceps during application. The bronchoscope is then slightly withdrawn to allow the forceps to be freely inserted beyond the bronchoscope. The forceps are opened as widely as possible as this stretches the airway walls and allows the foreign body to fall into the jaws of the forceps which is then firmly grasped. Care must be taken not to push the FB further down the airway. If the FB fits through the bronchoscope, then it is pulled right through without removing the bronchoscope. However, if the FB does not fit through the bronchoscope, then the bronchoscope has to be withdrawn with the FB trailing behind held by the forceps. It is important to keep your eyes (and hands) on the bronchoscope and forceps at all times.

The FB may become caught in the larynx or dropped into the trachea, causing complete airway obstruction. This possibility should always be anticipated and equipment be able to deal with this needs to be readily at hand. To prevent the FB being lost at the laryngeal inlet, the bevel of the bronchoscope is moved around over the FB by rotating the bronchoscope 90^0 and the bronchoscope is slightly tilted down at this area. A firm grip on the forceps with the FB must be maintained and hopefully, it is still there when the forceps is removed from the oral cavity. If the FB has been removed from the tracheo-broncial tree, but is not found in the forceps, the naso-oro-hypo pharynx should be checked in addition to a repeat bronchoscopy.

All throughout the procedure, it is imperative to listen to the sound of the oxygen saturation monitor for signs of desaturation and to inquire from the anesthesiologist regarding the condition of the patient. If desaturation occurs, the bronchoscope is moved back out of the bronchus and into the trachea to allow the anestheshiologist to ventilate the patient through the bronchoscope adaptor. If this is due to a large FB that slipped while in the trachea, then, the FB must be removed right away or pushed back into the bronchus to regain the airway.

Once the FB is removed, a second bronchoscopic examination is done to check for any pooling of secretions or blood that may need to be suctioned or for any remnant of the FB- which may have accidentally separated from the bigger piece- that has to be retrieved. Small pieces can often be removed by suctioning.

Rarely, a tracheostomy may have to be performed for a FB that, during extraction, will not fit through the laryngeal inlet. Tracheotomy is performed while the bronchoscope is in place and with the forceps grasping the FB. The FB is extracted through the tracheostoma. Afterwards, tracheostoma is closed with sutures and regular wound care is initiated.

If the procedure took less that an hour with minimal trauma, then the child is assisted with ventilation until he/she recovers full spontaneous respiration. A dose ofteroids may also be given (I.V. Dexamethasone, 1.0 to 1.5 mg/kg; maximum, 20 mg). The patient is brought to the post-anesthesia room and observed.

Delayed diagnosis and intervention (24 hours or more) were found to be related to higher complication rates such as recurrent or chronic pulmonary infections and prolonged hospital stay.[13] Thus, the need for early diagnosis and treatment of cases with suspected FB aspiration.

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