PAEDIATRIC BRONCHOSCOPY - AN OVERVIEW

* V. J. Vikram, **S. K. Jha, **D. Roy, **B. Chowdhury, **G. C. Sahoo

ABSTRACT

Bronchoscopy is frequently required procedure to diagnose and treat various pathologies affecting the airway like malignancies, foreign body, tumors etc. This article aims to exemplify the proper technique and handling of the bronchoscope in children, where it is frequently performed to remove foreign bodies stuck in the airway.

Key Words: Pediatric bronchoscopy.

INTRODUCTION

Bronchoscopy in children for removal of foreign bodies (F.B.) in the hand of a skillful endoscopist is very safe now due to advanced anesthetic techniques with constant monitoring of cardio-pulmonary function unlike some years ago when cardiac monitor or pulse oximeter were not available, cyanosis and pallor were the only signs of imminent cardiac arrest with impending danger to the child. Bronchoscopy is perhaps the most common endoscopic procedure usually done for the possibility of airway foreign body in children but unfortunately, it is still being regarded as a risky and unsafe procedure due to concern about the possible anesthetic complications in partially obstructed airway. However, contrary to this, bronchoscopy in children can help in sucking out the insipid secretions or mucous ping thereby removing the block in the obstructed airway where it is not possible for the child to cough it out to clear out the airway. Whenever there is a suspicion of trachea-bronchial F.B., the otolaryngologist must prepare for an early endoscopic intervention with adequate and careful preparation. As per Holinger, “If two hours are spent in preparations, the safe endoscopic procedure may take two minutes but if only two minutes are taken for preparation, the endoscopist may find himself attempting ineffective procedure for the next two hours”1. Bronchoscopy in children with airway F.B. may
cause hypoxia or anoxia at times. Hence, all the equipments must be chosen & assembled carefully before administration of anesthesia to avoid any catastrophic complications during the tenuous situation for immediate and adequate control of the airway by the endoscopist.

HISTORY:

Pioneering work was done by Chevalier Jackson in designing various useful instruments for safe & successful removal of foreign bodies. Other pioneers who developed the science of bronchoesophagology subsequently are Jackson Jr., Holinger and Tucker. Broyles (1963) and Holinger (1965) demonstrated fiber optic light and fiber optic carrier respectively for illumination in endoscope without any impingement on the narrow lumen. Brubaker and Holinger in 1972 introduced the method of still and motion picture photography through Storz Hopkins telescope. Wood and Fink in 1977 demonstrated the use of fiber optic flexible endoscope in children.

SURGICAL ANATOMY & APPLIED PHYSIOLOGY OF PAEDIATRIC AIRWAY:

The larynx in infant is not only relatively small, soft and sensitive but also it is high up and the submucosa is prone for edema. The glottis of a newborn infant has an antero-posterior length of 7-8mm and posterior transverse breadth of around 4-6 mm in which a mere 1 mm of mucosal edema can reduce the glottis space by 35-50% and similarly the sub glottis region with a diameter of 5-6mm can reduce the space by more than 40% and bronchus by mere 11% which may compromise the airway dangerously. The epiglottis at birth is at the level of first cervical vertebra and cricoids at third vertebra. The infant hyoid bone is very close to the larynx and the thyrohyoid membrane is very short. This unique relationship of high larynx in child makes its visualization and intubation difficult for the anesthetist. The chances of respiratory failure in infants are also high due to low respiratory reserve, narrow airway and high peripheral airway resistance. In infants and small children the functional residual capacity of lung is less, the BMR and oxygen consumption per minute are more and hence the heat loss is considerable to cause dehydration with rapid respiratory rate. All these anatomic & physiological peculiarities in the infants & children are challenging not only for the anesthetist but also for the otolaryngologist to perform a risky procedure as both of them fight for the same space in the airway which is already compromised.

INDICATIONS:

- Classical Diagnostic triad of unilateral wheezing, cough & ipsilateral diminished air entry.
- High degree of suspicion of F.B aspiration by pediatrician or parents.
- Shifting consolidation from one side to another.
- Tracheo-bronchial obstruction
- Atypical Asthma not responding to usual treatment.
- Persistent pneumonia or bronchitis
- History of violent cough or choking
- Presence of stridor or any evidence of airway obstruction
- Presence of radiological findings like obstructive emphysema on one side, collapse of lower lobe on either side and consolidation or collapse of lung
- Mediastinal shift to normal side in check valve obstruction
Early atelectasis & collapse with mediastinal shift towards the involved side ball valve obstruction.

**EQUIPMENTS & INSTRUMENTS:**

Storz ventilating bronchoscopes of various sizes from 2.5 mm to 6.0 mm with distal fiber optic illumination are usually used for pediatric bronchoscopy and it is better to use one size smaller endoscope for diagnostic purpose than optional. Fiber optic conventional rigid endoscopes with Halogen light source (250 Watts Halogen Lamp) & built in spare bulbs along with various types of F.B. holding forceps, suction canulas, cup shaped biopsy forceps, ‘Y’ type of suction tube to collect aspiration materials are basic requirements. Hopkins Telescope are necessary for diagnostic and photographic purposes with Xenon light source. Flexible fiber optic pediatric bronchoscopes are though ideal for diagnosis but are not useful for any endoscopic surgical procedure in infants & children as it may sometimes obstruct an airway already obstructed. It must be noted that the numbers indicating the size of the endoscopes are not on the outer diameter but the inner diameter. The table given below is a guide to use the correct size of bronchoscopes as per the age of the child.

**Operation Theatre Layout & Anaesthesia:**

There should be proper operation room set up before taking the child for endoscopy besides having checked all the necessary instruments & equipments. The surgeon usually sits at the head end & the anaesthetist on the left side of the child for consistently monitoring of heart & oxygen saturation by cardiac monitor and pulse oximeter. The light source should be kept behind the right hand side of the surgeon including the instrument trolley & suction machine. The assistant & the nurse should stand on the right side of the patient & a tracheotomy set should be kept ready for any eventuality on side. The photographic equipment with light source should be kept ready on right side for documentation. All the emergency drugs & all sizes of endotracheal tube must be kept ready including extra full oxygen & gas cylinder. In most cases, experienced & skilled anaesthetist is the key person for the success of the procedure who takes full charge of the situation to oxygenate the child adequately and give sufficient time to the surgeon to perform the procedure. In the event of slight evidence of bradycardia or falling of oxygen level, the surgeon should move out to give all the space & assistance to anaesthetist for avoiding cardiac arrest. Induction should be done with thiopentone, relaxation & apnoea with scoline & oxygenation is maintained with jet ventilation after introduction of endoscope. Many advantages & disadvantages of rigid Vs flexible bronchoscopy:

<table>
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<th>S.No</th>
<th>RIGID ENDOSCOPY</th>
<th>FLEXIBLE ENDOSCOPY</th>
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<tr>
<td>1.</td>
<td>Safer for F.B. Renewal</td>
<td>No suitable for removal of F.B.</td>
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<tr>
<td>2.</td>
<td>Multiple instruments &amp; telescopes can be used</td>
<td>Does not allow instrumentation</td>
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<tr>
<td>3.</td>
<td>Functions as protected airway for oxygenation &amp; anaesthesia</td>
<td>Does not function as protected airway for oxygenation and anaesthesia</td>
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<td>4.</td>
<td>Allows use of laser for treatment of lesions</td>
<td>Does not allow use of CO2 laser</td>
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<tr>
<td></td>
<td>Easy removal of granulations, thick</td>
<td>Compromises already obstructed</td>
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anaesthetists also prefer induction with inhalation anaesthesia or using halothane and maintain spontaneous breathing. Some anaesthetist use intravenous Ketamine instead of Pentothal but it is not as safe in endoscopic procedure as it does not abolish the pharyngeal & laryngeal reflexes. Before starting anaesthesia, a firm intravenous line should be established & infusion should be started.

TECHNIQUE OF BRONCHOSCOPY

After selecting an appropriate size bronchoscope according to the age of the child, it should be checked for proper illumination and cleaned thoroughly. A correct size suction cannula should be checked and passed through the bronchoscope. Out of various types of F.B. forceps like toothed, non-toothed, cupped, serrated, flat, crocodile, alligator etc. Selection should be done keeping in mind the type of bronchial F.B. which can assure a firm grip of the F.B. without damaging the bronchial mucosa. After visualising the larynx after lifting the epiglottis by the laryngoscope, the bronchoscope should be gently introduced into the glottis with the tip upwards and under the epiglottis. Bronchoscope should be held in the right hand with “pen hold” grip and should be gently slid into the trachea after visualising the vocal chords. The anaesthetist should then start inflating the lungs with Jet ventilation by the side of the bronchoscope. Failure to inflate the lungs with Jet ventilation and inability to identify the tracheal rings should alert that the bronchoscope is not in the air passage but in the oesophagus. After it is confirmed the endoscope is in trachea then it should be glided down over the left hand fingers without undue force and always under vision. The next step is the identification of carina and introduction of the bronchoscope into the right main bronchus with slight angulation towards the left. Then it can be withdrawn slightly and angled towards the right to visualise the left main bronchus. During the whole procedure, suction should be done from time to time to cleanse the secretions. The bronchus, bronchoscope and the F.B. should lie in one straight line before it is removed. The blades of F.B. forceps should be opened after it crosses the tip of the endoscope and then the F.B. should be caught firmly and brought near the tip of the bronchoscope. Then the bronchoscope along with the F.B. forceps should be gently withdrawn simultaneously till it reaches the glottis. After this, the bronchoscope should be tilted slightly upwards with the held F.B. to pass out through the posterior part of the glottis which is wider. Loose F.B. in trachea are more difficult which should not be caught directly when they are in the trachea, rather it should be pushed down to let them lodge in either main bronchus, usually the right main bronchus, after which it is easy to catch and remove. Otherwise, lone trachea F.B. may get stuck in the subglottic region which is the narrowest one in the airway, causing total airway obstruction until unless removed as early as possible.

After the removal of the F.B. the anaesthetist should oxygenate the child and allow the endoscopist to reintroduce the bronchoscope for inspection of tracheobronchial tree for any remnant of F.B. or a second F.B. rarely. The tracheobronchial tree should be cleaned with suction and bronchoscope should be kept in trachea for proper oxygenation till the breathing is spontaneous. Both the surgeon and anaesthetist should observe the child till the muscle tone returns to normal, cough reflex is present and child starts crying and air entry is checked on either side. The child should be kept
in left lateral position before shifting to ward and if there is any evidence of sub glottis oedema in the form of brassy cough or strider, then intravenous steroid should be given including strict observation of child.

**COMPLICATIONS:**

- Hypoxia, cardiac arrhythmia, hypercarbia, respiratory acidosis & other anaesthetic complications.
- Laryngeal or subglottic edema due to oversize endoscope & repeated instrumentation.
- Sub glottis impaction of F.B while removal.
- Post operative laryngeal spasm
- Aspiration of secretion or vomiting
- Inadequate ventilation leading to bradycardia, cyanosis, pallor & cardiac arrest.

**CONCLUSION:**

Paediatric Bronchoscopy is very safe and the most common indication is suspicion of F.B in airway. The anesthetist, endoscopist and assistants should work in tandem for a successful & safe procedure. The bronchoscope must never be pushed with undue force against resistance & should be always under vision. A meticulous planning & assessment is must by the surgeon & anesthetist before bronchoscopy.

**DISCLOSURES**

(a) Competing interests/Interests of Conflict- None
(b) Sponsorships - None
(c) Funding - None

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