

# Review Article

## Pediatric Flexible Fiberoptic Bronchoscopy

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### Introduction:

Flexible Fiberoptic Bronchoscopy (FOB) has revolutionized the practice of modern pulmonary medicine. Bronchoscopy is the most commonly used invasive diagnostic and therapeutic procedure in pulmonology. It is estimated that as many as 98% of all bronchoscopies are currently performed using the flexible instrument, and most bronchoscopists have never been trained in the technique of rigid bronchoscopies<sup>1</sup>. Flexible airway endoscopy has been used in clinical and research investigations of pediatric airway and pulmonary disorders for nearly 25 years. The evaluation and management of a variety of airway and pulmonary diseases in children has improved so also research investigations using bronchoalveolar lavage (BAL) and biopsy specimen have contributed extensively to our understanding of lung inflammation and infection. Improvements and new developments in fiberoptic endoscope technology, training of airway endoscopists, preoperative and sedative medications, patients monitoring continue to refine and enhance the pediatric clinical and research applications of flexible airway endoscopy<sup>2</sup>.

FOB has been utilized recently for diagnosis and therapy of airway and pulmonary disorders. Pediatric FOB differs significantly from that of adult in regard to anatomy and physiology of the central airways, indications, sedation and monitoring, common diagnostic findings and therapeutic options<sup>3</sup>.

Bronchoscopy may provide direct anatomical information or indirect information from secretions sampling, bronchial and transbronchial biopsies<sup>4</sup>.

FOB can be performed in any age group starting from 1-week old premature infant (600 g) to any age of children<sup>5</sup>. It can be used in children with versatile conditions like immunodeficient children<sup>6</sup>,

immunocompetent children<sup>7</sup>, being placed in ventilator<sup>8</sup>, HIV-associated pneumonia and pulmonary tuberculosis<sup>9</sup> and foreign body aspiration<sup>10</sup> etc.

### History of FOB

Gustav Killian of Germany first used rigid bronchoscope in 1897. Until late 1960s people were using refined rigid bronchoscope of Chevalier Jackson of USA. In 1968, Shigeto Ikeda of Japan introduced flexible FOB in adults. In 1978, Wood and his colleagues introduced pediatric FOB<sup>11</sup>. In India, N Somu, first did the pediatric flexible FOB in 1988<sup>12</sup>. In Bangladesh, rigid bronchoscopy was introduced in private sector in 1950s. In Govt sector, rigid bronchoscopy was started at the Institute of Diseases of Chest and Heart (IDCH) in 1962. In 1980s Flexible Fiberoptic Bronchoscopy (FFB) was first introduced at the Combined Military Hospital (CMH) in adults then at IDCH in 1995. The FOB in children was first started at the Institute of Child and Mother Health (ICMH) in 2000.

### Indications for bronchoscopy in pediatric patients

Table-1 lists the indications for flexible fiberoptic bronchoscopy in pediatric patients as outlined by American Thoracic Society<sup>13</sup>.

### Description of a pediatric fiberoptic bronchoscope (FOB)

The pediatric bronchoscopes are defined as those scopes with outside diameters of the insertion tube of less than 5.5 mm. (range 5.3 to 2.2). The parts of the FOB has been depicted in Fig-1. The insertion tube of the scope contains thousands of fiberoptic bundles i.e. fine glass fibers of 10-micron diameter that transmit the image and provide illumination. Light from a light source (Fig-2) enters through one end of the fiber and after repeated internal reflections is transmitted to the other end. Flexible scopes also have a small suction channel and a provision for controlled angulation of the distal end of the instrument (Fig-3).

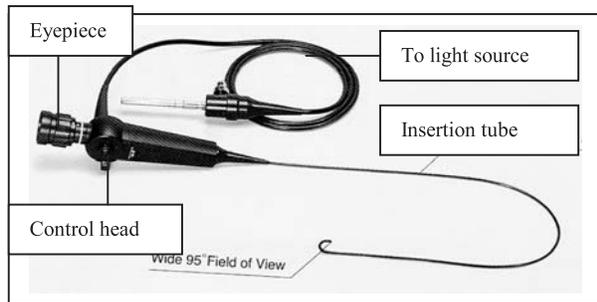
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**Table-I**  
*Lists of the indications for flexible fiberoptic bronchoscopy*

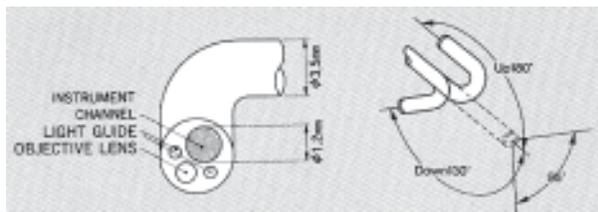
<ul style="list-style-type: none"> <li>• Chronic stridor</li> <li>• Persistent atelectasis</li> <li>• Persistent wheezing</li> <li>• Persistent or chronic cough</li> <li>• Recurrent or persistent pulmonary infiltrates</li> <li>• Hemoptysis</li> <li>• Lung lesions having radiographic abnormality</li> <li>• Suspected bronchial or tracheal foreign body</li> <li>• Vocal cord dysfunction</li> <li>• Removal of airway secretions and mucus plugs</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluation of upper airway trauma (accidental or prolonged intubation)</li> <li>• Samples of lower airway secretions and/or cells by bronchoalveolar lavage</li> <li>• Assessment of position, patency, or damage related to endotracheal or tracheostomy tubes</li> <li>• Assessment of damage from toxic inhalation or aspiration</li> <li>• Brush biopsies or transbronchial biopsies for pathology</li> <li>• Aid to difficult intubations</li> <li>• Therapeutic bronchoalveolar lavage</li> </ul>
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**Fig-1:** Fiberoptic bronchoscope with its different parts



**Fig-2:** Light source



**Fig-3:** Insertion tube diameter: 3.5mm. Field of vision: :95°

**Requirements for a bronchoscopy suite**

- An air-conditioned room with a central oxygen source having a system for humidified oxygen delivery with the appropriate connectors and with pediatric high flow capabilities.
- Appropriate pediatric sized flexible fiberoptic bronchoscope with a light source.
- Two suction setups, one for use through the bronchoscope and another for control and care of oral secretions.
- Resuscitation equipment with bag, mask, laryngoscope blades, and endotracheal tubes sized appropriately for infants and children.
- Mechanical monitors like cardiac monitor for continuous electrocardiography, pulse oximetry.
- Personnel: (1) bronchoscopy nurse who assists with medications, specimen collection, equipment care, and with specific technical needs of the procedure (2) one assistant for monitoring the patient and (3) one or two for holding the child during the procedure. It is preferable that all the personnel involved in the procedure should be trained in at least basic life support and pediatric advanced life support<sup>14</sup>.
- The bronchoscopist should be attired with sterile gown, cap, mask and gloves to make the procedure a sterile one taking other aseptic measures.
- The CXR or CT films are displayed in the view box of the bronchoscopy room for ready reference.

## Technique of bronchoscopy in children

### **Preparation of the patient**

- Maintenance of a quiet reassuring atmosphere.
- Good counseling of the parents / older child about the procedure depending on the level of education<sup>15</sup>.
- Taking written consent of the parents.
- Maintenance of an empty stomach at least 4 hours prior to bronchoscopy for all children greater than 5 years and clear liquids up to 2 hours for infants and young children before the procedure.
- CBC, blood group, bleeding and coagulation profile is carried out.
- An IV access is always inserted for use in case of any emergency.

### **Sedation and other medications of the child**

The form of sedation used most commonly for bronchoscopy is known as “conscious sedation” and is defined as a medically controlled state of depressed consciousness that:

- Allows protective reflexes to be maintained
- Preserves the patient's ability to maintain a patent airway independently and continuously unless intubated and
- Permits response by the patient to physical stimulation or verbal command<sup>16</sup>. Conscious sedation is achieved by intravenous (IV) administration of midazolam 0.05-0.1 mg/ kg over 2-5 minutes and IV meperidine 0.5-2.0 mg/ kg over 2-5 minutes or IV fentanyl 1-2 mg/kg or IV ketamine 0.5-2.0 mg/kg
- 2% nasal lignocaine jelly is applied into the selected nostril and the opposite nostril is occluded to allow the jelly to go inside or the child (if older) is asked to sniff by taking a deep breath
- Atropine 0.02mg/kg IV given just prior to procedure or 20 minutes before if given IM for vasoconstriction and secretion control
- Administer 100% oxygen to the child for 3-4 minutes prior to insertion of scope to prevent hypoxia during the procedure

### **Topical anesthesia**

Topical anesthesia of the upper airway applied after intravenous sedation greatly facilitates the

examination. Even with adequate intravenous sedation, topical anesthesia can minimize laryngospasm and vagal stimulation as well as minimize cough reflex. Lidocaine solution is used at 0.5% to 1.0% concentrations for patients less than one year of age and in 1% to 2% concentrations for patients of one year or older<sup>17,18</sup>. Viscous lidocaine in concentrations of 1% to 2% can be used for nasal anesthesia and lubrication prior to the insertion of the bronchoscope. Even nebulised lignocaine in a dose of 8mg/kg can be given<sup>19</sup>.

### **Connection and adjustment of the FOB**

The following steps are followed to prepare the FOB

- Connection of the FOB with the light source
- Connection of the light source with voltage stabilizer and the bronchoscope
- Adjustment of the eye piece of the bronchoscope
- Connection of the bronchoscope with the suction apparatus
- Checking the suction function of the bronchoscope and the sucker as well using normal saline
- Cleaning of the suction bottle with cydex to sterilize it so that BAL sample could be collected
- The lignocaine jelly is also applied to the outer surface of the distal end of the scope

### **Insertion of the bronchoscope**

- Nasal route is preferred as it avoids the scope from being bitten and damaged
- Visualisation of the glottis
- Instillation of two sprays of 1%-2% xylocaine into the glottis (two times, one minute apart)
- Wait for one minute to allow the vocal cord to be paralysed
- Passing through the vocal cord part (it is the most difficult part of doing bronchoscopy)
- Monitoring of the patient by pulse oximeter for SaO<sub>2</sub> and heart rate by cardiac monitor (by an anesthetist)
- Spray 1%-2% xylocaine into carina, or more may be needed if patient coughs
- Looking into the right principal bronchus and left bronchus and into their ramifications
- Doing special techniques like bronchoalveolar lavage (BAL), protected BAL, tracheobronchial biopsy and bronchial brushings
- Withdrawing of the insertion tube.

Of all the special techniques, BAL is most frequently used in infants and children.

### **Bronchoalveolar lavage (BAL) procedure**

1. BAL is performed after routine inspection/examination of the tracheobronchial tree and before biopsy or brushing is taken.
2. The suction channel of the bronchoscope is thoroughly rinsed with saline
3. The suction trap is changed
4. The tip of the bronchoscope is advanced until it is wedged into a subsegmental bronchus, usually at the level of the fourth and fifth branching
5. Both segments of lingula and right middle lobe are routinely lavaged and analysed separately
6. Other lobes may be lavaged if radiologically abnormal
7. One aliquot of total 3 aliquots of 0.9% sterile saline (prewarming the lavage fluid to prevent coughing and bronchospasm) is infused with a syringe with or without a 3-way stopcock into the suction port of the bronchoscope. (The amount of lavage fluid is not more than 5% to 15% of FRC of the child (FRC=1.3 to 1.5 X height or length in cm))
8. The fluid is then removed from the lung by the use of 50-80 mm Hg of negative pressure from an usual suction apparatus and collected into 50-100 ml specimen traps (made of polyethylene or polycarbonate)
9. Patient should be instructed to inhale and exhale deeply during fluid aspiration and maintain the suction channel of the bronchoscope in the centre of the airway lumen
10. The lavage procedure is repeated for five times in each site
11. The BAL fluid is sent for cell count, gram stain, culture, AFB, and other examinations like malignant cell, hemosiderin laden macrophage etc.

### **Complications of flexible FOB**

Serious complications related to flexible FOB are uncommon. The following are the most common complications that may occur related to flexible FOB in children<sup>20</sup>:

<b>Procedure related</b>	<b>Medication related</b>
Transient bradycardia	Patient discomfort (undersedation)
Transient hypoxia	Respiratory depression (oversedation)
Epistaxis	Inadequate topical anesthesia
Laryngospasm	vagal stimulation
Pneumothorax	laryngospasm
Hemoptysis	excessive cough
Nosocomial infection	bradycardia
Aspiration	urticaria
	paradoxical agitation (i.e benzodiazepines)

### **Contraindications for FOB**

There are no contraindications to flexible FOB in children. The following situations can pose serious risk during pediatric bronchoscopy<sup>13</sup>:

- Coagulopathy
- Bleeding diathesis (that can not be corrected)
- Massive hemoptysis
- Severe airway obstruction
- Severe refractory hypoxia
- Unstable hemodynamics
- Arrhythmias
- Inadequate training in pediatric life support

### **After care of the bronchoscope**

- The insertion tube is immersed into cidex in a tray for 15-20 minutes
- Cleaning the insertion tube with normal saline before reuse if needed
- Final immersion of the insertion tube into cidex
- Taking out the bronchoscope from cidex and placing on a flat surface
- Wiping the outside of the bronchoscope with a gauge piece
- Cleaning the suction channel with a long and slender brush with short and repeated to and fro movement
- Cleaning the shaft of the suction channel with another short brush
- Cleaning the mouth of the suction channel with the ultra-short broad brush
- Cleaning the suction channel with normal saline by giving full connection again
- Drying the suction channel with air giving suction with air only
- Applying the oil in the mouth of the suction channel
- Placing the bronchoscope into the brief with care

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