
Pulmonary Diagnostic Procedures: Bronchoscopy

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Bronchoscopy is currently the most commonly employed invasive procedure in the practice of pulmonary medicine. Both the rigid and flexible bronchoscopes are used to diagnose and treat various pulmonary disorders, in children the main diagnostic indications include infections, diffuse lung diseases, and airway problems. The bronchoscope is used too in application of laser therapy, placement of airway stents, and balloon dilatation to relieve airway obstruction caused by malignant and benign airway lesions.1 Today pediatric flexible fiberoptic bronchoscopy (FFB) is a safe diagnostic and interventional tool, even in young or extremely premature infants.2 Recent series3 explore newer applications, delineate potential complications, and make recommendations for its future application.

The technique and clinical application of bronchoscopy had their origins in 1897, when Gustav Killian used a rigid endoscope to examine the airways. Chevalier Jackson refined the rigid bronchoscope, which was the only type of instrument available for the evaluation of airways until the early 1970s, when Shigeto Ikeda developed the flexible fiberoptic bronchoscope. Flexible airway endoscopy has been used in clinical and research investigations of pediatric airway and pulmonary disorders for nearly 25 years. Not only has clinical use of the flexible bronchoscope improved our evaluation and management of a variety of airway and pulmonary diseases in children, but also research investigations using lavage and biopsy specimens obtained with the flexible bronchoscope 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, patient monitoring, and airway endoscopic techniques, as well as adjunctive minimally invasive and noninvasive diagnostic modalities, continue to refine and enhance the pediatric clinical and research applications of flexible airway endoscopy.4

One of the fathers of pediatrics bronchoscopy is Robert E. Wood5 who established that flexible bronchoscopy, with appropriate instrumentation and careful attention to physiological requirements of the patient, is safe and effective in pediatric patients. Over 1000 procedures an endoscopic diagnosis of direct relevance to the primary indication was established in 76% of the cases. The bronchoscope was most useful in the evaluation of patients who had stridor, atelectasis, persistent wheezing, or a suspected foreign body, and for patients who had tracheostomies. The high diagnostic yield and low complication rate strongly support the use of the flexible bronchoscope in the diagnostic evaluation of infants and children who have a variety of pulmonary problems.6

At the end of 1990s a collaborative study of ERS7 suggest that bronchoscopy in children was a well-established procedure at several European centres, while others are just beginning to use this technique. Fifty one European centres took part in the study. Discussion about sedation type are continued. Diagnostic BAL or extraction of mucous plugs should be accomplished with optimal control of the airway under general anesthesia. The use of the laryngeal mask airway (LMA) during flexible fiberoptic bronchoscopy is safe, provides excellent patient comfort, and should be utilized as an alternative to endotracheal intubation.8

INSTRUMENT MODELS

Presently, many ancillary instruments are available to accomplish various diagnostic and therapeutic procedures via the flexible bronchoscope. FFB is of great importance for diagnostic and therapeutic purposes in pediatric respiratory management. However, lack of a built-in channel in commercially available ultrathin fiberscopes has limited its usefulness in neonates and infants. They are different models of ultrathin flexible fiberoptic bronchoscopes (1.8, 2.3, and 2.7 mm in diameter). These instruments facilitate clinical procedures and evaluations that are difficult if not impossible with previous bronchoscopes. New applications include endoscopic transnasal intubation with endotracheal tubes as small as 3.0 mm (ID), inspection of the upper lobe segments in infants weighing less than 2.5 kg, and evaluation of the lower airways through endotracheal tubes as small as 2.5 mm (ID) or tracheostomy tubes as small as no. 00 (3.1 mm ID). Although some of these instruments have no suction channel and are thus

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incapable of removing airway secretions or obtaining specimens, they are extremely useful for many clinical purposes in infants and young children. New ultrathin flexible bronchoscopes with suction channel permit inspection and intervention (BAL) on airways in infants and neonates.10

The traditional fiberoptic bronchoscope is gradually giving way to videobronchoscope. The latter is a flexible bronchoscope equipped with a charge-coupled device at its distal tip. The bronchoscopic images are digitally captured and transmitted to a video processor for display on a television monitor. The advantage is that the excellent images can be simultaneously visualized by many, making it an excellent tool for teaching purposes. The images can also be stored in several digital formats. The disadvantages include the added expense of purchasing video equipment and a computer terminal, few pediatrics models available and the larger working and storage space required. The traditional fiberoptic instrument remains very valuable for direct visualization of airways.

DIAGNOSTIC BRONCHOSCOPY

Diagnostic flexible endoscopy for pediatric respiratory diseases is performed in many centers. Technical advances have resulted in performance of interventional bronchoscopies, and new diagnostic indications are being explored. Indications with documented clinical benefit include congenital or acquired progressive or unexplained airway obstruction. Pulmonary infections in immunodeficient children who do not respond to empirical antibiotic treatment may be diagnosed by bronchoscopy and bronchoalveolar lavage (BAL). The potential usefulness of bronchoscopy and BAL for managing chronic cough, wheeze, or selected cases with asthma or cystic fibrosis requires further study. The use of transbronchial biopsies (TBB) is established in pediatric lung transplantation. The role of TBB in the diagnosis of chronic interstitial lung disease in children remains to be determined. For a number of interventional applications, rigid endoscopy is required, and pediatric bronchoscopists should be trained in its use. Complications in pediatric bronchoscopy are rare, but severe nosocomial infection or overdosing with local anesthetics has occurred. The issues of quality control, video documentation, interobserver variability of findings, and educational standards will have to be addressed in the future as bronchoscopy use becomes less restricted to only large pediatric pulmonary units.11

Routine bronchoscopic visualization to detect endobronchial abnormalities, BAL, for the identification of many infectious and certain noninfectious lung diseases, and the use of bronchoscopy in brushing and biopsy of both visible airway lesions and bronchoscopically invisible parenchymal lung lesions are standard practice both in adults and children. The following discussion pertains to certain diagnostic procedures not routinely performed by pediatric bronchoscopists.

Bronchoscopic Needle Aspiration

A variety of invasive staging tests are available, including mediastinoscopy, thoracoscopy (video-assisted thoracoscopic surgery), transbronchial needle aspiration (TBNA), transthoracic needle aspiration (TTNA), and endoscopic ultrasound with fine needle aspiration (EUS-NA). Each of these tests requires specific skills, has particular risks, and has technical considerations making it more or less suitable for masses in particular locations.12 In pediatric are near anecdotal on adult patients series.

Bronchoscopic needle aspiration (BNA) of lymph nodes located in the paratracheal, subcarinal, and perihilar areas is useful in the diagnosis and staging of thoracic malignancies in adults. The technique can also be used in children in the diagnosis of endobronchial lesions that are submucosal and peripheral nodules and masses. The bronchoscopic needle has been used to drain bronchogenic and mediastinal cysts located adjacent to major airways or - more frequent - as the means of airway endoscopic monitoring during anesthesia for the surgical excision.13 Complications are rare and include pneumothorax and hemomediastinum. More commonly, inadvertent passage of the needle through the wall of the working channel of the flexible bronchoscope leads to expensive damage to the inner lining of the bronchoscope.

Fluorescence Bronchoscopy

Fluorescence bronchoscopy is a technique that detects early mucosal cancer by differentiating autofluorescence in normal and abnormal mucosa. Mucosa containing abnormal or malignant cells produces decreased auto-fluorescence. Mucosal changes observed by routine (white-light) bronchoscopy can be compared with those observed via green-light bronchoscopy.

Bronchoscopic Ultrasound

Clinical application of bronchoscopic ultrasound examination of the tracheobronchial tree is still in the investigational stage. The major advantage of this technique is the ability to visualize, via ultrasound, the extra-airway structures that cannot be seen through the bronchoscope. Preliminary studies have shown the ability to identify mediastinal structures including lymph nodes, great vessels, and esophagus.

Virtual Bronchoscopy

Virtual bronchoscopy does not involve bronchoscopy or insertion of any instrument into the airways. Images similar to those obtained with true bronchoscopy are
created from the data accrued from CT of the chest. Obviously, the main advantage of virtual bronchoscopy is the ability to visualize the endobronchial anatomy without actually performing bronchoscopy. Irrespective of the information gathered from virtual bronchoscopy, standard bronchoscopy or other procedures will be required to obtain tissue samples for histologic diagnosis. For now, virtual bronchoscopy remains an investigational tool.

Therapeutic Bronchoscopy

Therapeutic bronchoscopy to remove retained foreign bodies, respiratory secretions, mucous plugs, and blood clots from the airways is common. Frequently, diagnostic and therapeutic bronchoscopies are performed simultaneously.

Laser Bronchoscopy

Bronchoscopic treatment of airway malignancies is usually considered in patients with surgically unresectable lesions. The majority of bronchoscopic laser therapies are performed using the Nd-YAG laser. In adults Laser therapy can be used to treat both benign and malignant airway tumors that obstruct the major airways. Laser therapy also helps in preparing the airway for insertion of airway stents. Either rigid or flexible bronchoscopy can be used for application of laser energy, although the former accomplishes this more quickly. In children endoscopic laser surgery can be performed in the airway safely and effectively. The carbon dioxide (CO2) laser has been used to treat tracheobronchial pathology in children also. Four different types of pathologies have been successfully treated with the laser: selective cases of tracheobronchial stenosis following trauma and/or secondary to neonatal ventilation, posttraumatic tracheobronchial granuloma (due to foreign bodies or tracheotomies), tracheobronchial granulomas of infectious origin (tuberculosis), and selective cases of tracheobronchial tumor.15

Dilatation of Airway Stenosis

The rigid bronchoscope itself can be used as a bougie to dilate malignant or benign airway stenosis. Balloon dilatation through either the flexible or rigid bronchoscope is best suited for stenoses that are short in length. All types of dilatation procedures are effective if membranous or web-like lesions involving a very short length of the airways cause strictures and stenoses. Transmural strictures and strictures involving long segments of the airway require either surgical or stent therapy.

Airway Prostheses (Stents)

Airway stents made of metal, silicone, or other materials are available in various shapes and sizes. Stents can be placed in the obstructed airways to provide relief of symptoms caused by malignant or benign airway disorders. Stent therapy is more effective in patients with tracheal or main bronchial diseases than in those with airway diseases that involve lobar and distal bronchi. Use of the rigid bronchoscope is essential for the insertion, manipulation, and removal of silicone stents; metal stents can be inserted with the aid of flexible bronchoscopy. Complications seen with silicone stents include migration of stent and inspissation of thick mucous within the stent lumen. Metallic stents seem to promote growth of granulation tissue, which makes it difficult to remove and replace the stent. The use of airway stents in the pediatric population is uncommon, reflected in the few patient series reported in the literature. Metallic balloon-expandable stents are effective in relieving lower tracheomalacia and bronchomalacia in select patients. Only patients in whom conventional therapy has failed should be considered for stent placement.16 The use of tracheal stents in pediatric patients is not without risks.17

Tracheobronchial Foreign Body

Some reports did that rigid bronchoscopy is ideal for the extraction of aspirated tracheobronchial foreign bodies, especially in pediatric patients.18 Recent papers concluded that flexible bronchoscopic extraction of pediatric tracheobronchial foreign bodies can be performed safely with minimal risks and complications.19 Nevertheless, we caution that provisions be made to provide immediate rigid bronchoscopic management, should the attempts at flexible bronchoscopic extraction fail. In adults with airway foreign bodies, the pediatric flexible bronchoscope may be used to extract a foreign body that is impacted in airways too distal for access with the rigid bronchoscope.

REFERENCES