Flexible bronchoscopy

Pallav L Shah

Abstract

Bronchoscopy is an essential tool in respiratory medicine, which allows visualization and sampling from the main airways. It has an important role in the evaluation of suspected lung cancer, interstitial lung disease, persistent infection and the assessment of new pulmonary infiltrates in immunocompromised patients. It is a very safe technique which can be performed with or without conscious sedation. Recent developments have ranged from the improvement in image quality to integration of ultrasound. This has increased diagnostic sensitivity and facilitated image-guided biopsies of masses beyond the airways. The therapeutic role of bronchoscopy is also expanding from lung cancer to airways disease.

Keywords bronchoalveolar lavage; bronchoscopy; diffuse lung disease; endobronchial ultrasound (EBUS); lung cancer; transbronchial fine needle aspiration (TBNA); transbronchial lung biopsy

Flexible bronchoscopy is an essential basic investigation in respiratory medicine. It enables visual inspection of the airways down to the subsegments, and allows various samples to be easily obtained. The procedure is very safe and is performed as a day-case procedure with local anaesthesia, with or without short-acting intravenous sedation.

Rigid bronchoscopy is now primarily used for interventional procedures, such as removal of foreign bodies, tumour ablation and insertion of stents. It is also used routinely for staging before surgical resection of tumours by thoracic surgeons. The procedure is performed under general anaesthesia with assisted or spontaneous ventilation.

Indications

The indications for bronchoscopy are extensive (Table 1). Assessment of lung cancer was the key indication for bronchoscopy, but it also has an important role in the evaluation of persistent infection and diffuse lung disease. Therapeutic bronchoscopy (e.g. thermoplasty or valve insertion) is likely to play an increasing role in airway diseases, such as asthma and chronic obstructive pulmonary disease (COPD).

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What's new?

- The new integrated bronchoscopes with linear array Doppler allow sampling of masses and lymph nodes under ultrasound guidance of abnormalities adjacent to, but outside, the airway lumen. Mediastinal lymph nodes down to 5 mm in size can be sampled with this technique
- A new bronchoscopic treatment for asthma has been developed: bronchial thermoplasty
- Valves, umbrellas and drug-eluting stents have been developed to enable lung volume reduction

Equipment

The flexible bronchoscope comprises three bundles of optical fibres. Two carry light to the distal end and one transmits the

Indications for flexible bronchoscopy

Investigation of symptoms
- Haemoptysis
- Persistent cough
- Recurrent infection

Suspected neoplasia
- Unexplained paralysis of vocal cords or hemidiaphragm
- Stridor
- Localized monophonic wheeze
- Suspicious sputum cytology
- Unexplained pleural effusion

Staging of lung cancer
- Mediastinal tissue diagnosis and staging

Infection
- Identification of organisms (e.g. suspected tuberculosis)
- Evaluate airways if recurrent or persistent infection
- Bronchiectasis/lobar collapse,?cause

Interstitial lung disease
- Bronchoalveolar lavage for differential cell count and histology

Therapeutic and palliative
- Clearance of airway secretions
- Recurrent mucus plugging
- Foreign body removal
- Palliation of neoplasm
- Endotracheal ablation of tumour and stenting
- Treatment of airways disease
  - Bronchial thermoplasty for asthma
  - Bronchoscopic lung volume reduction for emphysema

Table 1

image from the distal end to the eyepiece. There is also an instrument/suction channel. The distal end can be angulated from a lever at the head, allowing the bronchoscope to be manoeuvred within the airway (Figure 1). The new video bronchoscope (Figure 1) has a video chip at the distal end, which is illuminated by optical fibres.

Bronchoscopes should always be cleaned and disinfected before use. Careful records must be kept, identifying which instrument was used in which patient.

Procedure

A pre-bronchoscopy checklist is shown in Table 2. It is good practice to give patients detailed written instructions about the procedure, and they should be advised not to eat or drink for at least 4 hours beforehand.

In the UK, most flexible bronchoscopies are performed with the patient sitting up at 45° degrees and the bronchoscopist in front of the patient (Figure 2). The oral pharynx is anaesthetized with 4% xylocaine and the nasal passage with 2% lignocaine (lidocaine) gel. Venous access should always be secured before the procedure, and oxygen administered via a single nasal cannula. Bronchoscopy can be performed with or without light sedation. Patients who have been sedated should be advised not to drive or handle any machinery for at least 24 hours after the procedure.

Patients are monitored by continuous oximetry throughout the procedure. Those with pre-existing cardiac disease or hypoxia not fully corrected by oxygen therapy should undergo continuous electrocardiogram (ECG) monitoring.

In the nasal approach, the bronchoscope is lubricated with 2% lignocaine (lidocaince) gel and passed through the nares under direct vision. It is then inserted into the nasopharynx until the epiglottis is visualized. In the oral approach, the patient is asked to bite gently onto a mouth-guard; the bronchoscope is then inserted through this mouth-guard into the posterior pharynx, to the level of the epiglottis.

The movement of the vocal cords is assessed, and they are then anaesthetized using 2 ml aliquots of 2% lignocaine (lidocaine). When the coughing has subsided, the bronchoscope is advanced through the widest part of the glottis, taking care not to touch the vocal cords. The subglottic area of the trachea is very sensitive,

Pre-bronchoscopy checklist

- Patient information – verbal and written
- Informed consent
- Full blood count and clotting – before transbronchial lung biopsy
- ECG if history of cardiac disease
- Prophylactic antibiotics if asplenia, heart valve prosthesis, cardiac murmur or history of endocarditis
- Intravenous access
- Spirometry
- Consider pre-treatment with bronchodilators if labile airways disease

Table 2

and patients initially feel as though they are choking. Further 2 ml aliquots of 2% lignocaine (lidocaine) are administered in the trachea, carina, and right and left main bronchi.

The bronchial anatomy down to the subsegmental level is carefully inspected for the presence of endobronchial lesions and mucosal abnormalities. Changes that may be seen include:

- erythema with increased vascular markings, oedema and increased secretions
- infiltration by malignancy (may be submucosal, which can be difficult to detect, or an easily identifiable polypoid tumour)
- small nodules (may be present in tuberculosis (TB) and occasionally in sarcoidosis)
- small ulcers (can occur in TB and occasionally in vasculitis, e.g. Wegener's granulomatosis)
- cherry-red vascular areas (seen submucosally in patients with endobronchial Kaposi's sarcoma)
- narrowing of the bronchial tree as a result of external compression from large lymph nodes or masses
- fibrosis causing traction of the airways and distortion compared with the normal anatomy.

Improvements in image acquisition continue to improve the diagnostic value of bronchoscopy. With fluorescence bronchoscopy the airway is illuminated by a blue light; normal tissue is visible as fluorescent green, whereas abnormal areas appear brown and red in colour. This absence of autofluorescence occurs in

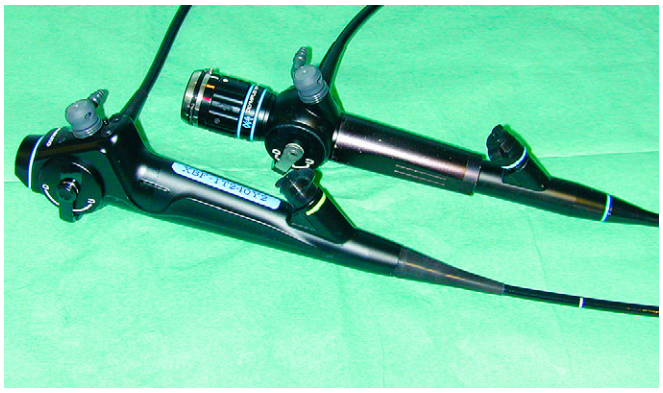

Figure 1 Fibre-optic bronchoscope (upper) and video bronchoscope (lower).

Figure 2 Fibre-optic bronchoscopy.

dysplasia, carcinoma *in situ* and invasive carcinoma, and may enable earlier detection of endobronchial tumours. Magnification of images and presentation at high definition further enhances the ability of the operator to detect subtle abnormalities.

Techniques

Bronchial biopsy: visible abnormalities in the trachea and bronchial tree should be biopsied (Figure 3). At least three or four adequate specimens should be obtained and placed in 10% formol saline solution. The diagnostic yield for polypoid lesions should be high (>90%), but is less for submucosal lesions.[1] Biopsy specimens should also be collected into saline and sent for culture when infection (e.g. TB) is suspected.

Bronchial brushings: a fine cytology brush (Figure 4) may be used to scrape cells from the surface of any visible lesion or from segments when the lesion is not visible at bronchoscopy. The bronchial brush specimen may be smeared onto a slide and fixed before cytological analysis, or shaken into saline for cytospin preparations. In the context of persistent respiratory infections bronchoscopy can be used to obtain samples directly from the affected area of the lung. Protected brush specimens allow sampling from a specific area without contamination from the proximal airways. The brush is usually enclosed by a double catheter and protected by a distal plug.

Bronchial washings: collection of bronchial washings involves injection of 20 ml of normal saline into the affected segment of the lung, followed by aspiration. Samples can be sent for both cytology and microbiology.

Transbronchial lung biopsy is used to obtain parenchymal lung tissue in the investigation of conditions such as sarcoidosis, organizing pneumonia, bronchoalveolar cell carcinoma and diffuse malignant infiltration. It is particularly useful when a bronchocentric component is visible on computed tomography (CT). The closed biopsy forceps (Figure 4) are advanced into the subsegment of the lung, and moved forwards as far as possible until they meet resistance. The forceps are then withdrawn a short distance and the jaws opened. The patient is asked to take a deep breath and the open forceps are advanced further. When they meet resistance again, the patient is asked to breathe out and a biopsy sample is taken during expiration. Samples are obtained from the extreme periphery of the lung and close to the pleural surface.

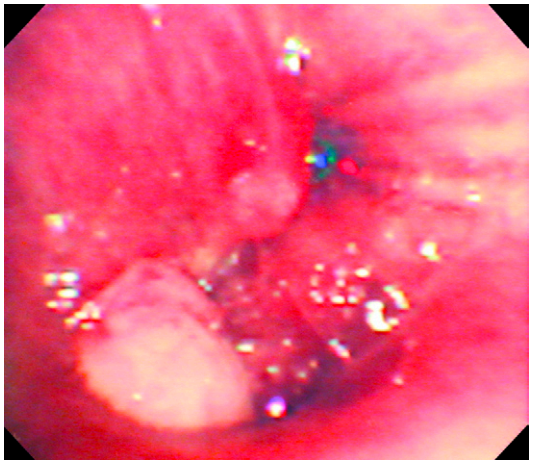

Figure 3 Endobronchial tumour occluding the left upper lobe and part of the lingula.

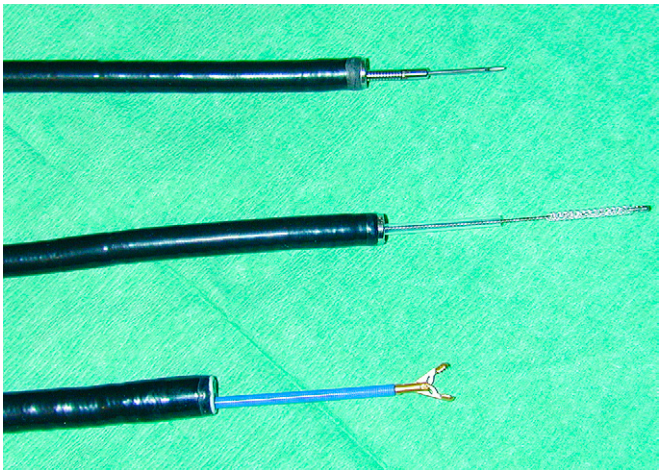

Figure 4 Accessories used for sampling at bronchoscopy. Transbronchial fine-needle aspiration needle (top), bronchial brush (middle) and biopsy forceps (bottom).

Bronchoalveolar lavage (BAL) is particularly useful in the assessment of interstitial lung disease. The bronchoscope is wedged into the segment of interest and three 60 ml aliquots of warm saline are injected into the segment; this is then slowly aspirated using low-pressure suction or direct hand suction. The return fluid is collected into a container made from siliconized glass, which minimizes adhesion of aspirated cells onto the container walls.

The differential cell count of the BAL fluid may suggest the diagnosis in interstitial lung disease (Table 3). Excessive numbers of lymphocytes (15–40% of the cell population) are present in sarcoidosis, TB, berylliosis and organizing pneumonia. In extrinsic allergic alveolitis, lymphocytes account for more than 50% of the cell population. A high neutrophil count (4–15%) is seen in fibrosing alveolitis, asbestosis and rheumatological disorders. A considerably higher neutrophil count is indicative of an acute infective process.

Transbronchial fine-needle aspiration (TBNA): mediastinal and hilar lymph nodes can be sampled by TBNA. The site of aspiration is planned on the basis of cross-sectional CT. The needle (Figure 4) is inserted at the desired point perpendicular to the airway wall. Needle aspiration of submucosal lesions may also improve diagnostic yield. Overall TBNA is a low-risk procedure with a good yield.[2,3]

Endobronchial ultrasound-guided transbronchial fine-needle aspiration (EBUS-TBNA): new integrated bronchoscopes with a linear array probe built into the tip of the bronchoscope allow sampling of mediastinal and hilar lymph nodes under ultrasound control. This further improves safety and the diagnostic yield in early studies to almost 90%.[4,5]

Bronchoalveolar lavage differential cell counts in diffuse interstitial lung disease

Lymphocyte excess	Neutrophil and/or eosinophil excess
15–40%	**Neutrophils**
• Sarcoidosis	*4–15%*
• Tuberculosis	• Fibrosing alveolitis
• Berylliosis	• Usual interstitial pneumonitis
• Drugs	• Asbestosis
• Organizing pneumonia	• Rheumatological disease
• HIV	
	> 50%
> 50%	• Infection
• Extrinsic allergic alveolitis	
	80–90%
	• Adult respiratory distress syndrome
	Eosinophils
	> 20%
	• Pulmonary eosinophilia

NB: Cell counts are increased in smokers.

Table 3

Bronchoscopy in palliation: flexible bronchoscopy is increasingly used for palliation. Endobronchial tumours causing significant occlusion of the main airways may be ablated by techniques including electrocautery, YAG laser, cryotherapy and photodynamic therapy, and stents may be placed in the trachea and main airways in patients with extrinsic or intrinsic obstruction from tumour or lymph node masses.[6,7]

Adverse effects

The adverse effects of flexible bronchoscopy may be attributable to the sedation, the local anaesthesia or the procedure. The overall incidence of complications is about 2%. Mortality from the procedure is about 0.02%.

Sedative drugs may depress respiration and have cardiovascular effects (e.g. hypotension). Lignocaine (lidocaine) may very rarely cause bradycardia, seizures, bronchospasm or laryngeal spasm. Note that the maximum dose of lignocaine (lidocaine) is 8.2 mg/kg, which is equivalent to about 29 ml of 2% lignocaine (lidocaine) in a 70 kg adult. However, considerably lower doses should be used in the elderly and in patients with comorbidity (particularly cardiac or liver disease).

The procedure may cause bronchospasm, laryngospasm, hypoxaemia or cardiac arrhythmias, particularly in patients with pre-existing cardiac disease or hypoxia not corrected by oxygen supplementation. Infection can be introduced by the bronchoscope; hence, it is essential to clean and disinfect all instruments before use. Haemorrhage and pneumothorax may follow transbronchial lung biopsy. The risk is 5–7%, and this is increased with paroxysmal coughing. Most cases of pneumothorax occur within 1 hour post-procedure; therefore, a radiograph should be obtained at this time. Hypoxia and precipitation of respiratory failure are the main hazards of bronchoalveolar lavage particularly as the procedure is often performed in patients with diffuse lung disease.

Operator and assistant safety

Protective clothing such as gowns or aprons, masks, eye protection and gloves should be worn during the procedure. Flexible bronchoscopy should be performed in a negative-pressure room when the patient has suspected TB or is at high risk of the disease. All staff should wear high-grade particulate filtration masks. Care should be taken when handling biopsy forceps and needles to minimize the risk of needle-stick injury. As a general rule, all staff should have appropriate bacille Calmette–Guérin (BCG) and hepatitis B immunization.

Recent advances

The role of bronchoscopy as a therapeutic tool is expanding. Bronchial thermoplasty for the treatment of asthma is being developed. This involves applying radiofrequency energy via a special catheter to the airways and selectively thermoablates the smooth muscle. A variety of techniques are being developed for emphysema which include the use of valves, umbrella-like devices and drug-eluting stents to bronchoscopically achieve lung volume reduction. ◆

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