Current status of fibreoptic bronchoscopy

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Introduction

The flexible fibreoptic bronchoscope was first made commercially available in 1970 (Anderson and Faber, 1978) and it has since had a major impact on the diagnosis and management of pulmonary disease. Within 3 years of its introduction, 25,000 broncho-fibrescopic examinations had been performed in the United States in 191 centres (Sackner, 1975). At the Brompton Hospital an average of 855 fibreoptic bronchoscopies have been performed annually since 1975. An earlier analysis of 1,223 of these showed that in most (81%), a histological diagnosis was made and no further diagnostic procedure was required (Mitchell *et al.*, 1980).

Following suitable preparation and pre-medication the fibrescope is normally passed through the nose under local anaesthesia; if the nasal passages cannot be negotiated it is passed through the mouth (Knight, 1981). Diagnostic indications for fibreoptic bronchoscopy include:

- (1) Possible endobronchial lesions.
- (2) Peripheral lung lesions.
- (3) Collection of samples for microbiological examination.
- (4) Diffuse lung disease of unknown aetiology.

Diagnostic bronchoscopy

Most fibreoptic bronchoscopies are performed for possible endobronchial carcinoma. The tumour is bronchoscopically visible in 48% of patients and in these a histological diagnosis can be made in over 90% of cases (Mitchell *et al.*, 1980; Martini and McCormick, 1978). If the tumour is not visible, the positive biopsy rate falls to about 40%. Peripheral endobronchial tumours beyond the visual range of the fibrescope may still be biopsied with fluoroscopy as may lung parenchymal tumours using fluoroscopy and transbronchial lung biopsy: here a positive histology rate of about 60% is found (Mitchell *et al.*, 1980). The diagnostic yield may be increased by combining forceps biopsy with brush cytology

(Kvale, Bode and Kini, 1976). Results improve with experience due to improved interpretation of the small biopsies by the pathologist and a better biopsy technique by the bronchoscopist (Knight and Clarke, 1979).

Local operability of endobronchial carcinoma can be assessed with the fibrescope. Extent of the tumour can be defined as can the mobility of the carina by observation of movement during breathing and coughing. Biopsy taken from the main carina in the absence of macroscopic abnormality gives a positive result in 10% of cases of carcinoma (Robbins *et al.*, 1979). In patients with enlarged mediastinal nodes causing external compression of the trachea, the carina or mainstem bronchi, a technique of trans-bronchial needle aspiration biopsy has been described (Zavala, 1981).

Complications associated with fibreoptic bronchoscopy are as follows: minor complications 0.2%; major 0.08%; mortality 0.01% (Credle, Smiddy and Elliot, 1974). Problems include reactions to the local anaesthetic, hypoxia, laryngospasm, bronchospasm and fever. In over 6,000 fibreoptic bronchoscopies performed at the Brompton Hospital no death has occurred.

Screening for carcinoma

It is, at present, inappropriate to use fibreoptic bronchoscopy as a screening procedure except in a few selected cases. Whenever sputum cytology is positive but the chest radiograph appears normal, bronchoscopy should be performed. Out of 499 patients with carcinoma, 12 had a normal chest radiograph; of these five had a positive mucosal biopsy at bronchoscopy (Mitchell *et al.*, 1980).

Intravenous administration of a derivative of haematoporphyrin, which has an affinity for malignant tissue, considerably increases the ease with which endobronchial tumour can be seen when viewed with red light from an argon dye laser. In addition, this technique may also have a therapeutic cytolytic effect on the malignant cells. However,

expensive laser equipment is required for this procedure (King *et al.*, 1982) and although it may be useful in individual cases, it appears to have no place in screening programmes. Furthermore, the photosensitization which results can be a problem for up to 2 weeks after the investigation (Hayata *et al.*, 1982).

Transbronchial lung biopsy

Transbronchial lung biopsy with the fibroscope may be useful in the investigation of diffuse lung disease but is not without risk. This method offers an alternative to open lung biopsy, which has a greater morbidity and mortality. Pneumothorax has been reported to occur in 2–5% (Knight, 1981; Zavala, 1976), and haemorrhage in 0.3–9% of transbronchial lung biopsies. The risk of pneumothorax is greater with percutaneous needle and trephine biopsy for a similar diagnostic yield (Borgesov and Francis, 1974).

Adequate tissue for diagnostic histology has been reported to have been obtained by transbronchial lung biopsy in 60–80% of cases (Levin, Wicks and Ellis, 1974; Zavala, 1978; Ellis, 1975). Without screening the diagnostic rate is less, 36–62% (Clarke *et al.*, 1977; Knight, 1981) but improves to 64–97% with fluoroscopy (Hanson *et al.*, 1976; Lefrak and Tuteur, 1977). The diagnostic yield is particularly high in sarcoidosis, 82%, (Mitchell *et al.*, 1980), and increases with the stage of the disease from 57% in stage I, 77% in stage II and 91% in stage III (Knight, 1981). In fibrosing alveolitis where the histology varies between different parts of the lung, transbronchial lung biopsy has been less useful in making a tissue diagnosis and open lung biopsy is preferred.

At the Brompton Hospital it is usual practice to perform transbronchial biopsy in patients with suspected sarcoidosis (stage II), opportunistic pulmonary infections and lymphangitis carcinomatosa. This investigation is no longer needed routinely in suspected cases of cryptogenic fibrosing alveolitis when an open lung biopsy is feasible.

Bronchopulmonary infections

In bronchopulmonary infections, expectorated sputum is not usually representative of lower airway flora because of contamination with oropharyngeal organisms. Fiberoptic bronchoscopy is a practical and relatively safe method of collecting uncontaminated specimens. This is of considerable importance for immunocompromised patients in whom the infection may be atypical and severe. It is possible to identify a variety of organisms by this method including viruses, bacteria and parasites.

Selected cultures can be performed by passing a sterile brush into the affected area of lung indicated by the radiograph. Several designs of brush have been assessed (Wimberley, Faling and Bartlett, 1979)

and a telescoping double-catheter with a distal ejectable plug is not contaminated by nasopharyngeal flora. The intact double-catheter is advanced into the infected area where the lower catheter is pushed out, followed by the brush itself; the brush is then withdrawn into the inner catheter. The whole double-catheter is then withdrawn from the bronchoscope, wiped with a formalin swab and the whole end, containing the brush, is cut with sterile scissors and put in a sterile container for microscopy and culture.

Pneumocystis carinii pneumonia is particularly amenable to diagnosis by transbronchial lung biopsy with a low incidence of false-negative results (Hodgkin, Anderson and Rosenow, 1973; Scheinhorn, Joyner and Whitcomb, 1974).

Cultures of washings obtained at bronchoscopy may be of considerable value in the diagnosis of both typical and atypical mycobacterial disease. Such cultures were important in the diagnosis of *Mycobacterium tuberculosis* in 47% of cases in one five year series (Jett, Cortese and Dines, 1981).

Therapeutic bronchoscopy

Aspiration of secretions with a fibroscope is now used frequently in patients being ventilated in intensive care units. In Japan, 28 of 35 surgical units routinely perform bronchial toilet post-operatively with a fibroscope to prevent complications after lung resection (Oho *et al.*, 1981). Clinical and radiographic improvement of atelectasis has been reported in 79% of cases following such bronchial toilet (Stevens, Lillington and Parsons, 1981). Removal of thick secretions requires a large suction channel and fibscopes with larger channels (2.6 mm) are available. Furthermore, fibscopes with two channels are also available so that lavage and suction can be performed at the same time to dislodge tenacious secretions (Geddes, 1980).

When endobronchial intubation is difficult, especially if extension of the neck is limited, the endobronchial tube can be threaded over the bronchoscope. This is then passed into the trachea and the tube advanced over it into the appropriate position (Hodgkin, Rosenow and Stubbs, 1975).

Broncho-alveolar lavage is now a recognized form of treatment for alveolar proteinosis (Brach, Harnell and Moser, 1976). The fibroscope can be used for this procedure but, at the Brompton Hospital, lavage through one side of a double-lumen endobronchial tube is found to be quicker and more effective as large volumes of lavage fluid can be instilled and aspirated through such a tube than through the smaller suction channel of a fibroscope (Costello *et al.*, 1975). This therapy has also been used for cryptogenic fibrosing alveolitis (Harris *et al.*, 1974).

There have been several reports of successful removal of foreign bodies via the fibroscope from the upper lobes and distal bronchi which are inaccessible to the rigid bronchoscope. This procedure has been made easier since the introduction of claws, baskets, special forceps and balloon catheters (Fieselman, Zavala and Keim, 1977).

Several forms of palliative therapy may be applied locally to endobronchial carcinoma through the fibroscope, reducing side effects which are often associated with such treatment. Local irradiation can be produced by inserting radioactive gold grains into the neoplasm (Foreman, 1977). Cytotoxic chemotherapy can also be injected directly into the endobronchial tumour. Direct injection of combinations of cytotoxic agents into adenocarcinoma, squamous and small cell carcinoma produced bronchoscopic and radiographic improvement in all, and clinical improvement in 18 of 22 patients (Waggai *et al.*, 1982).

Recently local, palliative laser treatment of endobronchial carcinoma via the fibroscope has been assessed (Hetzel *et al.*, 1983). In 34 patients, good palliation was achieved in just over 50%. Most patients tolerated treatment well and complications were minor, but two out of three patients who had complete bronchial obstruction died due to pneumonia following re-expansion of the lung. The best results were obtained in lesions involving the trachea or main carina. Patients must be carefully selected for this expensive form of treatment and must have mainly endobronchial tumour with normal, identifiable bronchial anatomy. Symptoms most often relieved are those due to bronchial obstruction or haemoptysis.

Contributions to research

Broncho-alveolar lavage

By irrigating pH-corrected normal saline into the segmental bronchus through the fibroscope and then aspirating the fluid, it is possible to sample both broncho-alveolar fluid and the free-cell population of the lung (Cole *et al.*, 1980). The immunology and cell biology of various types of pulmonary disease are being investigated directly in man instead of relying on serum or blood cell characteristics which may be different from those in tissue and are, at any rate, remote from the lung. Complications of this procedure are infrequent provided contraindications, such as cardiac disease and poor respiratory reserve, are observed. Occasional problems include acute respiratory distress, vasovagal syncope, fever and hypoxia.

Such studies are of considerable interest in patients with recurrent respiratory infections to defect abnormalities of local cellular immunity. Humoral defence mechanisms are represented in the wash fluid by IgG

and secretory IgA which are both synthesized locally and transported from the blood. Thus, opsonins are clinically important in pseudomonas infection (Reynolds and Thompson, 1973). IgG and IgA also act as antitoxins and neutralise viruses. Alveolar macrophages and lymphocytes form the main cellular differences and the broncho-alveolar lavage yield is such that it is possible to investigate the morphological and functional characteristics of these cells after separation.

In pulmonary fibrosis, cytology of the lavage fluid may be of help in diagnosis and treatment. In patients with sarcoidosis the differential lymphocyte count is increased to 35% and in allergic alveolitis up to 65%, compared with a normal count of 10% (Weinberger *et al.*, 1978). Patients with fibrosing alveolitis, eosinophilic granuloma and collagen disorders with lung fibrosis have normal lymphocyte counts but increased neutrophil counts and IgG concentrations. With fibrosing alveolitis the neutrophil count appears to fall with corticosteroid treatment, and in addition the lymphocyte count may be related to steroid responsiveness (Haslam *et al.*, 1980). The diagnostic value of lavage cell profiles in a case of diffuse lung disease is limited but sometimes helpful when considered in conjunction with other clinical information (Studdy *et al.*, 1983).

Regional lung function

Measurement of function in different regions of the lung can be of value in addition to assessing overall respiratory function. Lung disease is often localized to one area and surgery may be considered to remove the affected part. Before this is done it is important to determine the functional contribution of the diseased lung or part of lung and whether the remaining lung has enough reserve for adequate survival of the patient.

Regional lung function was first studied by using the respiratory mass spectrometer and the rigid bronchoscope (Hugh-Jones and West, 1960). However, this procedure was cumbersome and uncomfortable for both patient and operator but the fibroscope allows regional studies to be performed down to the segmental level in unanaesthetized patients with little discomfort. It is possible to pass thin flexible mass spectrometer probes down the fibroscope channel and sample the respiratory gases. In the lung as a whole, alveolar carbon dioxide pressure reflects the appropriateness of alveolar ventilation to metabolic need, but within parts of the lung it is an estimate of their ventilation relative to perfusion (Williams *et al.*, 1979). Different patterns of expired carbon dioxide trace from parts of the lung have been described reflecting disorders of ventilation or perfusion in those parts studied (West and Hugh-Jones, 1959).

Techniques have been developed using low concentrations of tracer gases to measure various detailed aspects of regional lung function (Williams *et al.*, 1979). With a single inspiration of carbon monoxide the diffusing capacity of small units of the lung can be measured (Denison *et al.*, 1980). Several inert tracer gases have been used to assess different aspects of lung function (Williams *et al.*, 1979). Argon, an insoluble gas, inspired in a single breath remains in the alveoli and its trace during expiration reflects the 'accessible' gas volume and evenness of ventilation. Freon, a soluble gas, is rapidly absorbed when inspired and the expiratory trace of this gas therefore reflects effective blood flow. If low concentrations of both these gases are combined in the same breath an index of ventilation relative to perfusion for that particular volume of the lung can be obtained.

Mucociliary clearance

Tracheal mucociliary clearance has been assessed by placing Teflon discs on the tracheal surface with a fibrescope and observing their upward progress using time-lapse cinephotography. Decreases in this index of mucus velocity have been shown in patients with chronic obstructive airways disease (Santa-Cruz *et al.*, 1974). The effects of oral and inhaled bronchodilators and anaesthetic agents on mucociliary clearance may also be studied by this technique.

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