Fibreoptic bronchoscopy without general anaesthetic

J Raine, J O Warner

Abstract
We have used flexible fibreoptic bronchoscopy using sedation and local anaesthesia in 50 children aged 2–19 years (median 10) using an Olympus BF-P20 instrument. Indications were opportunistic pneumonias (n=11), persistent atelectasis (n=11), recurrent pneumonia (n=7), miscellaneous lower airway disease (n=7), recurrent wheezing (n=3), haemoptysis (3), to diagnose infection or rejection of heart-lung transplants (n=3), stridor (n=2), suspected airway compression (n=1), evaluation of tracheostomy (n=1), and suspected foreign body (n=1). In 43 cases (86%) the diagnosis was related to the primary indication. In five (10%) unrelated abnormalities were found, and five (10%) were normal. In 13 (26%) treatment was altered as a result of flexible fibreoptic bronchoscopy. Complications were transient respiratory arrest (n=2), hypoxia (n=2), pneumonia (n=2), and laryngospasm (n=1). All complications were followed by complete recovery.

Our results suggest that flexible fibreoptic bronchoscopy is safe. Advantages over rigid bronchoscopy include greater visual range, fewer complications, and the avoidance of a general anaesthetic. Though invasive it can yield important diagnostic and therapeutic information.

The introduction of the flexible fibreoptic bronchoscope in 1969 transformed the practice of adult chest medicine by extending the diagnostic and therapeutic capabilities of the physician. Paediatric bronchoscopy has usually been done with a rigid (open tube) bronchoscope under general anaesthesia, to either retrieve foreign bodies or diagnose anatomical abnormalities, and most authorities still assert that this is the best way to visualise the airways in children.1 Technological advances have, however, led to the development of small flexible fibreoptic bronoscopes that are suitable for use in infants and children without a general anaesthetic.

This paper gives our experience with fibreoptic bronchoscopy done under sedation with local anaesthetic in the diagnosis and treatment of paediatric pulmonary disorders.

Patients and methods
Between January 1987 and November 1989, 50 flexible fibreoptic bronoscopies were carried out in children aged 2–19 years (median 10) (table 1). Those with opportunistic pneumonias were immunocompromised patients with acute lymphoblastic and myeloid leukaemia, and (in one case) AIDS related complex. The patients with persistent atelectasis had lobar collapse that had failed to respond to treatment with antibiotics given intravenously and physiotherapy. In seven of the cases the bronchoscopy was done to diagnose or exclude connective tissue diseases of the lung parenchyma such as fibrosing alveolitis. Six patients were bronchosced to see if there was an anatomical cause for recurrent pneumonia. The indication in three other patients was recurrent wheezing which had failed to respond to antiasthmatic drugs. In these cases another cause for the wheezing, such as bronchomalacia, was suspected. Three patients had bronchoscopies to determine the cause of unexplained haemoptysis—for example, a bronchial polyp. In three cases the bronchoscopy was done to help differentiate between infection and rejection in patients with cystic fibrosis who had had heart-lung transplants. In two patients chronic stridor, thought not to be caused by laryngomalacia, was the indication. In one patient airway compression caused by a vascular ring was the reason. In another, evaluation of a tracheostomy was the indication. The aim was to detect the presence of tracheomalacia or of any granulation tissue that may have required removal before decannulation. In a further patient there was a vague history of possible foreign body inhalation but no signs on examination or on the chest radiograph. The presence of a foreign body was thought unlikely and a flexible fibreoptic bronchoscopy was done to avoid the need for a general anaesthetic. In the last patient the bronchoscopy was done both to help investigate the cause of recurrent pneumonia and to do a bronchogram to diagnose the presence and extent of bronchietasis. Some of the patients, in particular those who were severely immunocompromised with recurrent opportunistic pneumonia, required more than one flexible fibreoptic bronchoscopy.

<table>
<thead>
<tr>
<th>Clinical indication</th>
<th>No (n=50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunistic pneumonias</td>
<td>11</td>
</tr>
<tr>
<td>Persistent atelectasis</td>
<td>11</td>
</tr>
<tr>
<td>Miscellaneous lower airway disease</td>
<td>7</td>
</tr>
<tr>
<td>Recurrent pneumonia</td>
<td>6</td>
</tr>
<tr>
<td>Recurrent wheezing</td>
<td>3</td>
</tr>
<tr>
<td>Haemoptysis</td>
<td>2</td>
</tr>
<tr>
<td>To diagnose infection or rejection of heart-lung transplants</td>
<td>3</td>
</tr>
<tr>
<td>Stridor</td>
<td>2</td>
</tr>
<tr>
<td>Suspected airway compression</td>
<td>1</td>
</tr>
<tr>
<td>Evaluation of tracheostomy</td>
<td>1</td>
</tr>
<tr>
<td>Suspected foreign body</td>
<td>1</td>
</tr>
<tr>
<td>Bronchogram in patient with recurrent pneumonia</td>
<td>1</td>
</tr>
</tbody>
</table>

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In no case did this result from technical failure of the initial bronchoscopy. An Olympus BF P20 (external diameter 4.9 mm, working channel 2.2 mm) was used (figure). The bronchoscopy was carried out in a bronchoscopy suite with facilities for resuscitation. A nurse trained in the techniques of fibreoptic bronchoscopy assisted the operator. A second nurse or doctor observed the patient and the monitors. Patients were fasted for at least four hours before the procedure. Premedication was with pethidine 1–2 mg/kg and midazolam 0.1–0.3 mg/kg, both given intravenously. Lignocaine gel was used to anaesthetise the nose and 2% lignocaine liquid (instilled through the working channel of the bronchoscope) was used to anaesthetise the vocal cords, carina, and both main bronchi. Additional aliquots of 2% lignocaine liquid were sometimes instilled in the lower airway to control coughing. The bronchoscope was inserted through the nose. A small volume bronchial lavage with 5–10 ml of normal saline was done on each occasion. To avoid contamination from the upper respiratory tract suction was not used until the tip of the bronchoscope was beyond the carina, and the first aspirated sample was discarded.

Large volume bronchoalveolar lavage (30–120 ml depending on the size of the child) was done if there was any suspicion of interstitial lung disease. The bronchoscope was wedged in a segmental bronchus and normal saline injected through the working channel. All specimens were sent for cytological and microbiological analysis. Cytological analysis comprised a total cell count and percentage values of macrophages, neutrophils, lymphocytes, and eosinophils. Cells were also examined for evidence of fungal, viral, protozoal, and parasitic infection. Thirty five transbronchial biopsies were done, all under fluoroscopic control. For safety reasons only one lung was biopsied at any one bronchoscopy. All patients were continuously monitored with an oximeter. Oxygen was given through the free nostril or through the suction channel of the bronchoscope if low oxygen saturations were recorded on the oximeter. A chest radiograph was performed after all bronchoscopies. Naloxone was given routinely at the end of the procedure in the bronchoscopy suite to reverse the effects of the pethidine. Flumazenil was given to reverse the effects of the midazolam if indicated.

Results

The diagnoses are shown in table 2. In 43 cases (86%) the abnormal findings were directly related to the primary indication for flexible fibreoptic bronchoscopy. In five cases (10%) abnormalities unrelated to the primary indication were found. In another five the findings were normal. In some patients both abnormalities related to the primary indication and unrelated abnormalities were found.

Chronic inflammation was diagnosed if there was a chronic inflammatory infiltrate with a predominance of lymphocytes in the biopsy specimen. Acute inflammation was diagnosed when erythematous mucosa and purulent secretions were seen during bronchoscopy. The opportunistic organisms causing the pneumonias were Pneumocystis carinii (n=2), Candida albicans (n=2), cytomegalovirus (n=2), and measles (n=1). In none of the above cases was the organism identified on examination of the sputum. In those pneumonias in which an organism was identified this was done on analysis of the bronchoalveolar lavage fluid and confirmed in two cases by the biopsy specimen. None of our patients required open lung biopsy. Haemoptysis in our three cases was secondary to severe infection, a haemangioma, and idiopathic

Table 2 Diagnosis at fibreoptic bronchoscopy

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No (n=50)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic inflammation/fibrosis</td>
<td>19</td>
</tr>
<tr>
<td>Generalised acute inflammation</td>
<td>8</td>
</tr>
<tr>
<td>Opportunistic infection with identified organism</td>
<td>7</td>
</tr>
<tr>
<td>Normal</td>
<td>5</td>
</tr>
<tr>
<td>Haemoptysis: cause found</td>
<td>3</td>
</tr>
<tr>
<td>Tracheal/bronchial compression</td>
<td>3</td>
</tr>
<tr>
<td>Bronchomalacia</td>
<td>2</td>
</tr>
<tr>
<td>Bronchial stenosis</td>
<td>1</td>
</tr>
<tr>
<td>Bronchial plugging</td>
<td>1</td>
</tr>
<tr>
<td>Cytotoxic lung damage</td>
<td>1</td>
</tr>
</tbody>
</table>

The Olympus BF P20 fibreoptic bronchoscope. Box: end view of tip of bronchoscope. A=working channel, B=fibreoptic light bundles, and C=lens.
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pulmonary haemosiderosis, respectively. Tracheobronchial compression was secondary to lymph nodes in two cases and a vascular ring in a third. Bronchomalacia was attributed to the Williams-Campbell syndrome in one and confirmed by bronchography, which showed severe airway collapse on expiration. Bronchial stenosis with persistent atelectasis was diagnosed in a patient with a history of a severe pneumonia who was immunologically normal, and bronchial plugging with persistent atelectasis was found in a patient with cystic fibrosis. Cytotoxic lung damage was diagnosed in a patient with leukaemia who had interstitial fibrosis and calcification in the alveolar walls on biopsy. In 13 (26%) of cases, treatment was changed as a direct result of flexible fibreoptic bronchoscopy. Six of the seven patients with opportunistic pneumonia in whom the responsible organism was identified were started on the appropriate treatment. In the seventh (with measles) treatment of the giant cell pneumonia was not changed as there is no specific treatment. One of the patients with cytomegalovirus pneumonia had a further bronchoscopy two weeks after treatment with gancyclovir to assess whether further treatment was necessary. Cytomegalovirus was still present in the lavage fluid and treatment was continued. One patient with Streplococcus pneumoniae in his lavage fluid, but not in his sputum, was started on the appropriate antibacterial treatment. Another patient who had been diagnosed as having left main bronchus stenosis was given prophylactic antibiotics and physiotherapy during the winter. A patient with a tracheostomy who had been considered suitable for decannulation did not have the procedure after the discovery of severe tracheal stenosis at the tracheostomy site. A patient with compression of the left main bronchus that was thought to be caused by a vascular ring (as a result of variation in size of the bronchial lumen with systole and diastole) was referred for cardiac catheterisation, which showed a pulmonary artery sling; this was cured by operation. The patient with bronchomalacia was referred for bronchial stenting.

Major complications comprised respiratory arrest (n=2), hypoxia (n=2), pneumonia (n=2), and transient laryngospasm not requiring intubation (n=1). Both cases of respiratory arrest occurred in patients with pulmonary hypertension and cor pulmonale. In both reversible was rapidly achieved with naloxone. In the hypoxic patients the oxygen saturation's lowest reading was 70% and lasted for only a few seconds. The pneumonias were mild and treated in both cases by antibiotics given orally; they did not prolong the patients' stay in hospital. In the patient with laryngospasm it had not previously been possible to examine the tracheobronchial tree adequately. This patient was subsequently referred to a thoracic surgeon for a rigid bronchoscopy. Minor complications were also encountered.

Two patients had hallucinations during the bronchoscopy, secondary to midazolam, and required further sedation with pethidine. Some of the patients who had had biopsies had slight blood streaking of the sputum for a few hours after the procedure. Several of the patients had minor epistaxis, which in all cases stopped before the end of the procedure, having responded to compression of the nares for a few minutes. All complications were transient and followed by complete recovery. There was total amnesia for the procedure in all cases.

Discussion
Flexible fibreoptic bronchoscopy is a routine procedure in adult chest medicine. Wood started his pioneering work into paediatric flexible fibreoptic bronchoscopy in 1978 in the United States.2 He used the bronchoscope to diagnose and treat a wide variety of disorders including some that had previously required rigid bronchoscopy. He successfully carried out the bronchoscopies under sedation, thus avoiding the need for a general anaesthetic with all its attendant complications.

Flexible fibreoptic bronchoscopes are the instruments of choice in most bronchoscopies. They can be passed through the nose or mouth, though an endotracheal tube, or through a tracheostomy. They provide a dynamic view of both the upper and lower airways. Laryngomalacia, tracheomalacia, the effects of endobronchial lesions such as granulation tissue and tumours, or extrabronchial compression can safely be seen without the distortion caused by a rigid tube. The small directional tip of the flexible bronchoscope enables better visualisation of the upper lobe bronchi and distal bronchi. Flexible fibreoptic bronchoscopy can be done with the child in bed and does not require moving a sick patient with several intravascular lines to an operating theatre. Furthermore, the expense of using the operating and recovery rooms is avoided.

Rigid bronchoscopy requires a general anaesthetic and is associated with subglottial oedema that can lead to stridor and laryngospasm. The rigid instrument is, however, more suitable in certain circumstances. These include removal of foreign bodies, operative manipulations such as dilatation of a bronchial stenosis, and the evaluation of large haemoptyses during active bleeding. Rigid bronchoscopes are also more useful in the search for H-type tracheoesophageal fistulas and the critical evaluation of the posterior aspect of the larynx, as in a patient with bilateral vocal cord paralysis.3

Indications for flexible fibreoptic bronchoscopy in Wood's series of 1095 patients published in 1984 comprised stridor (24%), atelectasis (17%), miscellaneous lower airway disease (17%), tracheostomy evaluation (15%), miscellaneous upper airway disease (9%), recurrent or persistent pneumonias (7%), wheezing (6%), suspected airway compression (3%), and haemoptysis (2%).4 Indications in our series were somewhat different. This is partly because our hospital is a tertiary referral centre and partly because there has been an increase in the number of patients undergoing immunosuppressive treatment in the treatment of malignancies and after transplantation. In one of our cases the indication for flexible fibreoptic bronchoscopy was a suspected foreign body. If the

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presence of a foreign body is strongly suspected we refer the patient for a rigid bronchoscopy. If the evidence is equivocal we perform a diagnostic flexible bronchoscopy and then refer the patient for a rigid bronchoscopy if a foreign body is found. Using this approach in a series of 52 patients Wood and Gauderer found foreign bodies in 10 (19%). Rigid bronchoscopy was thus avoided in most patients.

There are no absolute contraindications to bronchoscopy but clearly patients with severe airway obstruction, pulmonary hypertension, severe coagulopathies, or profound hypoxaemia are at higher risk than others. Both our patients who had respiratory arrests had pulmonary hypertension. The arrests were thought to be caused by the premedication rather than effects of the procedure.

Diagnoses relevant to the indication for the bronchoscopy were found in most of our cases. In a series of patients Wood found abnormalities relevant to the primary indication for bronchoscopy in 76% of cases, abnormalities not relevant to the primary indication in 15%, and normal findings in 9%. Normal results were often important in excluding abnormalities. Surprisingly the diagnostic yield among the opportunistic pneumonias was greater on the results of culture of lavage fluid than on examination of the biopsy specimen. An accompanying neutrophilia in the lavage fluid was a helpful confirmatory sign of pyogenic infection. De Blic et al found that analysis of bronchoalveolar lavage in immunocompromised children with opportunistic pneumonias led to a specific diagnosis in 60% of cases. Using the method described above contamination from upper airway secretions was avoided in most cases. In adults specimens may be collected with brushes protected within a catheter to avoid contamination. Collection systems currently available are, however, too large to pass through the paediatric flexible bronchoscope. The diagnosis of the infectious agent in an opportunistic pneumonia may mean that open lung biopsy is not necessary. In Wood’s series and in ours treatment was changed in an appreciable number of cases as a direct result of the bronchoscopy.

The flexible fiberoptic bronchoscopy can occupy a large part of the airway. This relative disadvantage in a patient with already compromised respiration can be overcome by using appropriately small instruments, and there are now ultrathin instruments with an outer diameter of 2.2 mm.

All the complications that we encountered were transient and followed by complete recovery. In retrospect, the dose of pethidine used in the two patients who developed respiratory failure was too high. The effects of pethidine and midazolam can rapidly be reversed by naloxone and flumazenil, respectively. In Wood’s series of 1095 procedures there were four important complications, none of which was fatal. Two patients developed a pneumothorax, one had laryngospasm requiring brief intubation, and one developed a lung abscess after a bronchogram. Twenty eight patients developed minor complications including epistaxis, transient laryngospasm, transient bradycardia and anaesthetic complications, none of which required intervention. One death after flexible fiberoptic bronchoscopy has been reported (in a 2 year old child with severe pulmonary hypertension, congestive heart failure, and a history of severe laryngomalacia).

Rigid bronchoscopy is well established in paediatric practice. Flexible fiberoptic bronchoscopy is a safe procedure with low risks which has appreciable advantages over the rigid instrument and is useful for the evaluation of children with pulmonary disorders. We feel that the change in treatment in 26% of our cases as a direct result of the bronchoscopy is strong justification for its use.

Development of small fiberoptic bronoscopes with extended capabilities is under way. Adaptors that attach to the endotracheal tube and allow a bronchoscope to be inserted while maintaining mechanical ventilation are available. Nd:YAG have been used using the working channel as a port for low frequency oscillatory ventilation, an improvement that will provide an extra margin of patient safety. Wire nests that can be passed through the working channel of the flexible fiberoptic bronchoscopy are being developed for the retrieval of foreign bodies. Balloons to dilate strictures and fibroptic laser for use in patients with conditions such as subglottic stenosis are also being developed.

Normal values exist for differential cell counts in bronchoalveolar lavage fluid in adults, and these are helpful in diagnosing various diseases such as cryptogenic fibrosing alveolitis. Knowledge of normal and abnormal paediatric cell counts in lavage fluid would be helpful in the diagnosis of interstitial lung diseases in children. A randomised controlled trial comparing the diagnostic yield in opportunistic pneumonias obtained by analysis of lavage fluid and bronchoscopic biopsy specimens compared with those obtained at open lung biopsy would be of great interest. The rarity of these conditions, however, would make the logistics of such a trial difficult.

We predict that the role of flexible fiberoptic bronchoscopy in paediatric pulmonology will expand in the future.

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