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Flexible bronchoscopy under 10 kg

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We report 35 bronchoscopies performed in 27 post-neonatal subjects weighing less than 10 kg using an Olympus BC3F20 (3·5 mm diameter) bronchoscope. Twenty-three procedures were performed primarily for investigation of airway anatomy and 12 primarily for broncho-alveolar lavage. Mild oxygen desaturation responsive to increased O_2 administration was common. Major complications were infrequent with two children developing lower respiratory tract infection and one patient requiring ventilation overnight. The diagnostic yield was high with 76% of studies in children suspected of airway anomalies proving positive. We conclude that bronchoscopy in this age group is well tolerated and identifies a significant number of abnormalities.

Introduction

Flexible fibre-optic bronchoscopy is now a well established technique in adult respiratory practice. However, it is only in the last 10 years that a flexible bronchoscope suitable for children has become available allowing the development of flexible bronchoscopy in paediatric respiratory practice (1). The indications and technique differ significantly from that in adults. The focus of attention has been in older children. More recently an 'Ultrathin' scope (2·2 mm outer diameter) has been used in the investigation of neonates (2). We report our experience over a 2-year period of flexible bronchoscopy performed under sedation in small children weighing less than 10 kg using a paediatric flexible bronchoscope.

Methods

PATIENTS

We performed 35 bronchoscopies on 27 children (14 males, 13 females) less than 10 kg (weight 3·3–9·5 kg; age 4 weeks–2·14 years). Three infants were examined while undergoing ventilation in the intensive care unit; all the others were examined under sedation breathing spontaneously. There were two major indications (Table 1) for bronchoscopy in these children; (a) the investigation of possible airway abnormalities and (b) the performance of broncho-alveolar lavage to assess the likelihood of aspiration or infection.

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BRONCHOSCOPY PROTOCOL

All the studies were performed using an Olympus BC3F20 flexible bronchoscope, external diameter 3·5 mm, channel 1·2 mm. The channel is large enough to permit suction and lavage but is not large enough to allow the passage of biopsy forceps.

In each infant, nasal cannulae for continuous oxygen administration were attached and an intravenous line sited prior to pre-medication with oral Triclofos (75 mg kg^{-1}) and Otrivine nose drops 1 h prior to the study. At the beginning of the procedure intravenous Midazolam (0·1–0·15 mg kg^{-1}) and Pethidine (1–2 mg kg^{-1}) were given in a dose titrated to induce moderate sedation. All patients were monitored with ECG and pulse oximetry and were given low flow oxygen throughout the procedure. At the end of the procedure, the patient was assessed and intravenous Naloxone given to those in whom it was indicated on clinical grounds.

Three patients were examined while intubated and ventilated in the ITU. All children had at least a 4·5 mm diameter Portex endo-tracheal tube. A special adaptor fitted to the patient manifold (Portex) allowed the bronchoscope to pass easily and hand ventilation to continue during the study.

BRONCHO-ALVEOLAR LAVAGE

For BAL, 2–3 ml kg^{-1} of 0·9% sodium chloride in five equal aliquots were injected into the bronchoscope suction channel with the bronchoscope wedged. Aspiration was carried out after each fraction had been injected. The first sample of each aspiration was processed as a 'bronchial' sample while the remainder were pooled as 'alveolar'.

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Table 1 Clinical indications for investigation by flexible bronchoscopy

	No. of children	No. of studies
Anatomical		
Stridor	11	11
Lobar collapse/consolidation*	9	11
Tracheal abnormality*	1	1
Broncho-alveolar lavage		
Aspiration	3	3
Infective pneumonitis	1	1
Interstitial pneumonitis	1	7
Investigation of hypercapnea and radiological changes	1	1

*Two children with collapse/consolidation and one with tracheal abnormality had bronchography.

Lavages were usually performed in the right middle lobe and the lingula.

BRONCHOGRAPHY

Three studies were performed per-bronchoscopically using Oihexol (Omnipaque, Nycomed), a water soluble dye (Table 1). While this gives less good contrast than Lipiodol, this dye allows injection to be repeated on more than one occasion during one study. Once the bronchoscope was located in the area of interest 0·5–1 ml (240 mg ml^{-1}) of contrast was injected through the channel and an X-ray film taken.

Results

ANATOMICAL

The examination was abnormal in 16 subjects (76%; Table 2). All of the children with stridor had an identifiable cause found on bronchoscopy. Four children with stridor and an upper airway anomaly had a coexisting abnormality in the lower airway. In these small children, none had an unsuspected foreign body. We consider a clinical diagnosis of inhaled foreign body to be a relative contra-indication to flexible bronchoscopy; any such children would proceed directly to rigid bronchoscopy.

The presence of the bronchoscope allowed bronchograms to be performed in three children to confirm the endoscopic diagnosis.

BRONCHO-ALVEOLAR LAVAGE

Six children had 12 BAL studies (Table 2). Three were judged normal with no abnormality on cell count or culture. The child with interstitial pneumonitis (3) had regular BAL to monitor her progress. These studies showed an abnormal differential cell count with a lymphocytic predominance and a loose association between cell counts and clinical status. One child investigated for possible aspiration was found to have laryngomalacia but no evidence of aspiration. The remaining child had airway endoscopy with lavage to investigate persisting respiratory symptoms and radiological abnormalities. The airways were normal but *Pseudomonas aeruginosa* was isolated from respiratory secretions and the child was subsequently found to have cystic fibrosis.

COMPLICATIONS

Minor

Most children experienced mild (80–85%) transient falls in oxygen saturation, easily treated by increasing inspired oxygen concentration. Only rarely was it necessary to withdraw the bronchoscope and allow a child to stabilize before continuing the examination. Five patients were given Naloxone following the procedure to reverse the opiate sedation. No child had epistaxis following the procedure. We attribute the absence of this complication to the routine use of decongestant nose drops with the initial pre-medication.

Major

These were uncommon in children without endobronchial abnormality. Two children developed lower respiratory tract infection and were treated successfully with intravenous antibiotics and physiotherapy. One child developed progressive stridor a number of hours after bronchoscopy and proceeded to intubation and ventilation overnight. All recovered fully.

Discussion

In many situations, flexible bronchoscopy has advantages over rigid bronchoscopy in the investigation of respiratory disease in children. It does not require a general anaesthetic and the natural dynamics of the airway can be studied under sedation and it is therefore possible to demonstrate both static and dynamic obstructions. In addition, the degree of angulation of the tip and the small size of the flexible scope allows good visualization of the apices and gives greater access to segmental bronchi than a rigid bronchoscope.

Previous studies have outlined the use in older children of the standard paediatric scope (1,4). In this

Table 2 Bronchoscopic findings in children studied

Indication for bronchoscopy	Number studied	Findings
Anatomical		
Stridor	5	Laryngomalacia
Stridor	1	Laryngomalacia+Tracheomalacia
Stridor	2	Laryngomalacia+Tracheomalacia +Bronchomalacia
Stridor	1	Tracheomalacia
Stridor	1	Narrowed mild trachea
Stridor	1†	Narrow distal trachea+left main bronchus
Right upper lobe changes	3	Normal
Right upper lobe changes	1*‡	Absent apical segmental bronchus and narrow left main bronchus
Right lower lobe changes	1	Stenosis right main bronchus
Left lower lobe changes	1	Stenosis left main bronchus
Left upper lobe changes	1‡	Absent left upper lobe bronchus
Herniated left upper lobe	1	Normal anatomy
Multiple lobar collapse	1	Normal anatamoy
Suspected tracheal anomaly	1‡	Tracheal stenosis
Broncho-alveolar lavage		
Aspiration	1†	Lipid-laden macrophages
Aspiration	2	No evidence (1 Laryngomalacia)
Interstitial pneumonitis	1	Inflammatory cells
Possible opportunistic infection	1	Normal
Investigation of abnormal radiological changes	1	Pseudomonas in secretions

*Required ventilation within 24 h of procedure.
†Developed lower respiratory tract infection following procedure.
‡Bronchogram performed.

report we emphasize that bronchoscopy is clinically useful in infants and small children and can be performed easily and safely under sedation in this age group.

We had two broad indications for flexible bronchoscopy. The first was to investigate possible structural abnormalities related to the presence of stridor or persistent/recurrent radiological opacification. This gave a high yield (76%) of significant pathology. Even if an abnormality was seen in the upper airway the remainder of the respiratory tract should be examined to exclude possible co-existing pathology. Dual pathology has been reported as occurring in 15–45% of all children (4,5). In our group, five children (24%) suspected of structural anomalies demonstrated dual pathology.

The second broad indication was to perform BAL. The Olympus BC3F20 paediatric bronchoscope is the smallest instrument presently available with a channel sufficiently large to allow lavage. Three children suspected of having pulmonary aspiration were examined for the presence of lipid laden macrophages in BAL fluid which is a sensitive marker of this problem (6). However most (64%) of the BAL examinations were carried out to monitor one child to monitor the progress of interstitial pneumonitis.

In conclusion, we have found flexible bronchoscopy using the 3·5 mm Olympus B3CF20 bronchoscope to be of considerable assistance in the diagnosis and management of small children with respiratory symptoms. Overall 20 children (74%) had significant findings, similar to the 75% reported in a large American review of 1000 studies in children of all ages (4). In most children, the procedure was well tolerated. Complications, mostly minor, tended to occur in children with abnormal airways. We conclude that flexible bronchoscopy with the standard paediatric scope is of great value in infancy and early childhood.

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