Paediatric Flexible Bronchoscopy and its Indications

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Abstract
Paediatric flexible bronchoscopy (F.B.) with bronchoalveolar lavage (B.A.L.) is an increasingly important investigation. Retrospective review of 180 FB performed over a 5 year period by a single operator was undertaken. Common indications included recurrent lower respiratory tract infections (n=92, 51%), persistent atelectasis (n=43, 24%), persistent infiltrates (n=18, 10%) and persistent consolidation (n=17, 9%). Normal airway anatomy was identified in the majority (n=154, 85.5%). Bronchomalacia was identified in 22 cases (12%). Thick purulent secretions were seen in 40 bronchoscopies (22%). Commonest organisms cultured on BAL were H. influenza (n=22, 12.2%), Streptococcus Pneumoniae (n=18, 10%) and Staph aurus (n=9, 5%). Cytomegalo virus (C.M.V.), Candida (n=1, 0.5%) and aspergillus fumigatus were identified (n=7, 4%). Bronchoscopic findings frequently guided management (n=90, 51%). No significant complications occurred. Flexible bronchoscopy procedure, patient and equipment care were in adherence with best practice guidelines. Paediatric F.B. is a safe and useful procedure when clinically indicated.

Introduction
Fiberoptic flexible bronchoscopy was introduced into paediatric practice in the 1970’s and has both diagnostic and therapeutic applications. The paediatric flexible bronchoscope is longer and thinner than the rigid bronchoscope and includes a channel for suctioning and instrumentation. The tip of the instrument may be manipulated, to direct the instrument into an individual lobe or a segmental bronchiole. Newer neonatal bronchoscopes (outer diameter 2.2mm) and improved anaesthetic techniques allow for diagnosis and assessment of airways in small preterm infants.

Methods
A retrospective chart review was performed following ascertainment of study population from both operating theatre and respiratory department records. All FB procedures were performed in one tertiary level paediatric university hospital by a single operator. Patient details, indication for procedure, co-morbidities, clinical and radiological information, bronchoscopy findings, BAL results and complications, if any were entered into an Excel database for review.

Results
Patient demographics
Over a four year period (2005-2009), 180 FBs and 180 BALs were performed bilaterally Patient age ranged from 7 weeks to 17 years (mean 6 years 10 months). 51% were males. Co-morbidities included cystic fibrosis, primary ciliary dyskinesia, cerebral palsy, metabolic disorders, (glycogen storage disease type III, galactosaemia), trisomy 21, immune suppression post renal transplant, human immuno deficiency virus (HIV), hyper-IgE syndrome, cerebellar astrocytoma and congenital muscular dystrophy.

Bronchoscope size and approach utilised
The 3.5 mm flexible bronchoscope was most commonly used (n= 92, 51%), followed by the 2.8 mm (n=52, 29 %) and the 5.0 mm bronchoscope (n = 36, 20 %). All FB were performed under general anaesthesia in theatre. Laryngeal mask airway was used in 78% (n= 141) , endo-tracheal tube in 20% (n=37) and nasopharyngeal approach in 1% (n=2) of cases.

Indications
The most common indications for FB included recurrent lower respiratory tract infections (LRTIs) (n=92, 51%) of which 11 had cystic fibrosis (CF) and 1 had primary ciliary dyskinesia (PCD), persistent atelectasis, (n = 43, 24 %) of which 3 had CF and 2 had PCD; persistent infiltrates (n=18, 10%) of which 3 had CF; persistent consolidation (n=17, 9%) and a history of haemoptysis (see Table 1).

Diagnostic yield -Bronchoscopy findings
Normal airway anatomy was seen in the majority of cases 85.5% (n=154). The most common abnormal anatomy was mild bronchomalacia of left main stem bronchus 7.0% (n=12), followed by right middle lobe bronchomalacia 3% (n=5) and right main stem bronchomalacia 0.5% (n=1). Bronchomalacia was identified in 5 cases of persistent atelectasis, 4 cases of recurrent LRTI and 3 cases of persistent consolidation. A tracheal bronchus (pig bronchus) was seen in 2% of cases (n=4). Thick purulent secretions often occluding the bronchoscope were seen in 22% (n=40), generally associated with friable mucosa. Bronchoscopic instillation of recombinant human DNase was instilled in 10% (n=18) of cases.
Intraluminal lesion was identified in a patient with persistent lower lobe atelectasis which was subsequently removed together with the involved lobe by the cardiothoracic team. Histology revealed carcinoid tumor. Two patients had macroscopic blood stained BAL.

**Diagnosis**

Microbiological culture of BAL revealed a significant growth in 31% of cases (n=56). The commonest bacteria cultured in decreasing order were Haemophilus influenzae 12% (n=22), Streptococcus Pneumoniae 10% (n=18), Staph aureus (5% n=9) followed by Moraxella Catarrhalis 2% (n=4) and Methicillin resistant Staph aureus (MRSA) 2% (n=4) (Table 3). Mixed cultures were seen in 21% of all positive BAL cultures (n=38). There was one new case each of Burkholderia Cepacia and Pseudomonas Aeruginosa, both in known CF patients. CMV was identified in 2% (n=4) (Deaf test positive). A scanty growth of Aspergillus Fumigatus was identified in 4% (n=7), three of whom were patients with CF and one patient had bronchioloalveolar carcinoma. One patient had a heavy growth of candida albicans. There were no positive Pneumocystis jiroveci (PCP) cases. Cytology was performed on all BAL specimens, (n=180). Neutrophils were identified in cases of significant bacterial infection. Grade 1 lipid laden macrophages (LLM) were identified in 18% (n=32), grade II in 31% (n=56), and grade III in 0.6% (n=1).

**Complications**

There were no major complications directly related to the procedure: in particular no significant desaturations requiring the procedure to be abandoned, significant haemorrhage, pneumothorax or intensive care unit admissions. One patient with a cardiomyopathy sustained an anaesthetic induced arrhythmia prior to the FB and the FB was deferred.

**Change in patient management**

31% (n=56) were treated with appropriate antibiotics based on significant bacterial BAL culture. Anti-fungal treatment was given to the patient who cultured heavy candida. 2% (n=4) patients in whom Cytomegalovirus (CMV) was identified underwent further investigations including CT thorax, neuromaging, hearing test, ophthalmology and infectious disease review and Guthrie card review. Two patients with red blood cells and haemosiderin laden macrophages on BAL were thoroughly investigated for same. If bronchomalacia with pulsatility was identified, radiological imaging to rule out aberrant vessel was performed. The patient with endobronchial lesion proceeded to lobectomy and carcinoid was identified.

**Best practice guidelines for FB procedure, equipment and patient care**

Flexible bronchoscopy procedure, equipment storage, cleaning and traceability and post operative patient care concur with international guidelines. The diagnostic yield for FB will depend on the population studied and the previous investigations and treatment performed. The diagnostic yield of FB is high when combined with BAL microbiology and cytology often leading to changes in patient management. When bronchomalacia with pulsatility was identified at FB (n=21, 12%), either magnetic resonance imaging/angiogram or CT thorax with pulmonary angiogram were performed to rule out an aberrant vessel. Recombinant human DNase instilled in 11%, (n=17) of our cases has been previously shown to be therapeutic in persistent atelectasis unresponsive to medical therapy. All patients with significantly positive bacterial growths on BAL were treated with an appropriate antibiotic. Those in whom CMV was identified underwent detailed investigation to identify whether the CMV was antenatally acquired or not and whether there were associated complications e.g. CMV pneumonitis etc. Our patient population does not include oncology patients and helps explain the lack of PCP identified.

**Discussion**

Flexible bronchoscopy is a useful procedure when clinically indicated. Currently three centres nationally perform this procedure. FB is indicated when benefits outweigh risks. Relative contraindications include baseline hypoxia, pulmonary hypertension and uncorrected bleeding diathesis. In children a normal bronchoscopic examination can be of great value and normal airway anatomy was seen in the majority of our cases (85%, n=154). The definitive exclusion of suspected problems (e.g. tracheal haemangiomata) may be as important as its diagnosis.

Our indications for flexible bronchoscopy concur with international guidelines. Our centre is a centre for cystic fibrosis which accounted for some of our bronchoscopies for recurrent RTI. Patients with stridor are generally referred to the otolaryngology service at the hospital.

In the past the presence of lipids in alveolar macrophages has been used clinically as an indicator of aspiration. More recently the lipid-laden index in children may, in part reflect processes other than aspiration, such as airways obstruction. Lipid laden macrophages are graded 1-3. Our patient, with a chronic cough who had grade III lipid laden macrophages in the right middle lobe and grade 0 elsewhere did not have aspiration identified on videofluoroscopy. Our two cases of haemoptysis, anaemia and fluffy infiltrates on chest radiograph and haemosiderin laden macrophages were subsequently diagnosed with idiopathic pulmonary haemosiderosis. This rare disorder has a poor prognosis despite treatment (85% 5 year survival). We experienced no significant complications. Life threatening adverse events involved drug overdose, inadequate monitoring or inappropriate sedation. While major complications include apnoea, bradycardia and significant oxygen desaturation (SaO2 <90%), minor complications include epistaxis, airway bleeding excessive cough and transient laryngospasm. Guidelines for patient and equipment care have been previously published and were adhered to in our centre. In our hands FB with BAL is a safe procedure, having both diagnostic and therapeutic indications and frequently guiding management.
References