Airway foreign body removal by flexible bronchoscopy: experience with 1027 children during 2000-2008

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Background: **Foreign body aspiration (FBA) into the tracheobronchial tree is a common problem in children necessitating prompt recognition and management. This study aimed to report our experience in airway foreign body removal by flexible bronchoscopy in children.**

Methods: **A total of 1027 patients with FBA were reviewed retrospectively. They were 626 boys and 401 girls aged from 5 months to 14 years with a median age of 17 months. The clinical manifestations, radiological findings, bronchoscopic findings and complications of the procedure were analyzed.**

Results: **Among the patients, only 53.4% had a definite history of FBA. The most frequent symptom was paroxysmal cough (84.3%), followed by stridor or wheezing, fever and dyspnea. Chest X-ray showed emphysema in 68.8% of the patients, atelectasis in 13.3% and bronchopneumonia in 56.3%. A bronchoscope was inserted intranasally in most children, but through mouth and endotracheal tube in 17 and 3 children, respectively. Foreign bodies were removed successfully by flexible bronchoscopy with disposable grasping forceps or biopsy forceps in 938 (91.3%) of the patients. The other 89 patients turned to rigid bronchoscopy. During the procedures, 132 (12.9%) of the patients showed transient hypoxia, which was alleviated by oxygen supplement and/or temporary cessation of the procedure. A small amount of bleeding was found in 17 patients and bradycardia in 3. Air leak and laryngeal edema were noted in 2 patients and relieved within 24 hours.**

Conclusions: **Flexible bronchoscopy is useful and safe in retrieving airway foreign bodies in children. With skilled personnel and perfect equipments, flexible bronchoscopy could be considered as the first choice for the removal of airway foreign body.**

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Introduction

Aspiration of foreign body (FB) into the tracheobronchial tree is a common problem in children, necessitating prompt recognition and early management. A delay of diagnosis and retention of FBs usually increase morbidity and mortality, ranging from fatal airway obstruction to recurrent cough or wheezing. The bronchoscopic removal of FBs can be traced back to 1897, when Gustav Killian performed the first bronchoscopy with a rigid esophagoscope and successfully removed a FB from a farmer's airway.[1-3] Later, rigid bronchoscopy was considered as the main procedure for management of FB aspiration (FBA) because of its advantage of a wide working channel and availability of required equipment for FB extraction.[3-6]

Since the 1970s, flexible bronchoscopy has been widely used in the diagnosis and treatment of various respiratory diseases in adults and children, including the initial evaluation of FBA patients.[2,7-9] It allows doctors to get a detailed evaluation of the location and type of FB and airway changes with minimal complications. Although the application of flexible bronchoscope in FB removal has not been widely accepted,[10-12] accumulated experience in FBA removal using a fibrobronchoscope as the first choice has been reported in adults and children in recent years.[4,5,13,14] Our unit, a provincial pediatric hospital with more than 800 beds, receives patients from all over the province and also from the neighboring districts. Since 1997, we have tried to apply fibrobronchoscope in the initial evaluation and retrieval of FBs. With experience accumulated, the

procedure has been gradually accepted.

In this article, we analyzed the clinical data of 1027 children with FBA and reviewed our experience with therapeutic flexible bronchoscopy for extraction of FBs.

Methods

A total of 1027 pediatric patients with FBA undergoing flexible bronchoscopy from January 2000 to August 2008 were enrolled. They were 626 boys and 401 girls aged from 5 months to 14 years with a median age of 17 months. The duration of FB retention ranged from 1 hour to 3.5 years with a median of 2 weeks (Table 1).

Depending on the age and body weight of the patients, three kinds of fibrobronchoscopes including Olympus BF-XP40 (external diameter: 2.8 mm, working channel: 1.2 mm), BF-3C30 (3.6 mm, 1.2 mm) and BF-P40 (4.9 mm, 2.2 mm) were used. Other ancillary equipments included disposable spiral grasping basket type forceps FG (spiral basket type, 3Fr), biopsy forceps FB-56D-1, digital video work station, life monitors, oxygen supply system and emergency equipment.

Informed consents were obtained from the patients' parents before the treatment. No food or drink was taken within 6 hours before operation. Flexible bronchoscopy was performed under sedation and local anesthesia. Diazepam (0.1-0.2 mg/kg) and atropine (0.01-0.02 mg/kg) were administered intramuscularly 20-30 minutes ahead of the operation before 2007, while midazolam (0.1-0.15 mg/kg) was injected 5-10 minutes ahead of the operation since 2007. Aerosolized lidocaine was sprayed on the throat first, then lidocaine was dripped into the trachea and bronchus for local anesthesia during flexible bronchoscopy. Bronchoscope was inserted intranasally unless there was nasal stenosis which caused difficulties in inserting. For the latter condition, the bronchoscope was inserted through mouth under the protection of mouth gag. For those with intubation, it was inserted through the endotracheal tube. Spiral grasping basket type forceps or biopsy forceps were used to remove the FB. Adrenaline was administered if necessary. Bronchoalveolar lavage (BAL) was performed for microbiological determinations in patients with a long duration of >15 days or presentation with inflammation during or after the FB was removed as we previously reported.[15]

Heart rate, respiratory rate, and SpO_2 were monitored during the whole procedure, and if the patients were hypoxic (cyanosis, low SpO_2 and/or high heart rate), oxygen of appropriate concentration was given by mask, and the procedure was ceased temporarily when necessary.

Results

Among the 1027 patients, only 548 (53.4%) had a definite history of FBA; 39 patients had a history of unsuccessful rigid bronchoscopy. The most common symptom was paroxysmal cough (866, 84.3%), followed by stridor (672, 65.4%), fever (438, 42.6%), dyspnea (135, 13.1%), cyanosis (79, 7.7%) and hemoptysis (13, 1.3%). Common signs included dry or moist rale (659, 64.2%), wheezing (241, 23.5%) and decreased breath sound (273, 26.6%). Chest X-ray showed lateral or segmental

Table 1. The characteristics of patients with airway foreign bodies

Characteristics		Numbers
Gender (male/female)		626/401
Age	<1 year	101 (9.8%)
	-3 years	746 (72.6%)
	-7 years	153 (14.9%)
	>7 years	27 (2.6%)
	Median age	17 months (5 months-14 years)
Duration	<24 hours	52 (5.1%)
	-1 week	256 (24.9%)
	-1 month	527 (51.3%)
	-1 year	165 (16.1%)
	>1 year	27 (2.6%)
	Median duration	2 weeks (1 hour-3.5 years)

Table 2. Types of airway foreign bodies

Type		Numbers (%)
Vegetable snacks	Peanut	316 (30.8)
	Watermelon seed	213 (20.7)
	Sunflower seed	198 (19.3)
	Sarcocarp	58 (5.6)
	Semen aesculi	22 (2.1)
	Bean	11 (1.1)
	Fruit	6 (0.6)
	Squash seed	5 (0.5)
	Others	12 (1.2)
	Total	841 (81.9)
Animal foods	Fishbone	27 (2.6)
	Pig bone	22 (2.1)
	Chicken bone	16 (1.6)
	Mud eel bone	3 (0.3)
	Pork or chicken	11 (1.1)
	Others	4 (0.4)
	Total	83 (8.1)
Stationeries	Head of pencil	7 (0.7)
	Pen caps	4 (0.4)
	Rubbers	3 (0.3)
	Others	5 (0.5)
	Total	19 (1.9)
Thin leaf milkwort stem and leaf		16 (1.6)
Plastic toys		4 (0.4)
Ball bearing		1 (0.1)
Unknown FBs		63 (6.1)

emphysema in 707 patients (68.8%), atelectasis in 137 (13.3%), bronchopneumonia in 578 (56.3%), pneumothorax in 11 (1.1%), pneumomediastinum in 27 (2.6%), subcutaneous emphysema in 3, pleural effusion in 7, pleural thickening in 2, and local bronchiectasis in 2. Moreover, mediastinum swing was noted in 479 (61.2%) of 783 patients who underwent chest fluoroscopy. The chest fluoroscopy of the other 108 patients (10.5%) appeared normal.

The most common location of FB was the right bronchus (468, 45.6%), followed by the left bronchus (402, 39.1%), bilateral bronchi (49, 4.8%), and the trachea (108, 10.5%). Of the FBs, 453 (44.1%) were lodged in segmental or smaller bronchi, and 204 (19.9%) in the left or right upper lobe. Most of the FBs (841, 81.9%) were vegetable snacks. Animal foods were found in 83 patients (8.1%), and stationeries were noted in another 19 patients (1.9%) older than 3 years. Other FBs included thinleaf milkwort stem and leaf, plastic toys and ball bearing. Unknown FBs were retrieved in 63 patients (Table 2).

Most of bronchoscopes were inserted intranasally in our patients, except through mouth in 17 patients (1.7%) and through the endotracheal tube in 3. In all the patients, 938 (91.3%) had FBs removed successfully by flexible bronchoscopy, among them 927 patients (98.8%) by spiral basket type forceps and 11 patients (6 with botanical FBs and 5 with fish bones) by biopsy forceps. BAL was performed in 378 patients (36.8%) during or after removal of FBs. Altogether 89 patients turned to rigid bronchoscopy because of the location of FBs near the epiglottis or glottis, or failure of FB removal by flexible bronchoscopy.

During the procedure, 132 patients (12.9%) showed hypoxia, which was transient and alleviated by oxygen supplement or temporary cessation of the procedure. A small amount of bleeding was found in 17 patients (1.7%) with good outcome after local administration of adrenaline. Bradycardia was noted in 3 patients. Air leak and laryngeal edema were noted in 2 patients and relieved within 24 hours. Pneumomediastinum, subcutaneous emphysema, and laryngeal spasm with postoperative tachypnea were noted in 2 patients, which were relieved within 24 hours.

Among the 1027 patients, 562 were given antibiotics. In 938 patients with FBs removed successfully by flexible bronchoscopy, 37 (3.6%) received bronchoscopy more than once. The duration of hospitalization of these 938 patients ranged from 2 to 52 days with a median of 5 days.

Discussion

FBA is a common and life-threatening situation in children. As previously reported,[16-19] most patients are at the age of 1-3 years and boys are predominant. Snacks such as sarcocarp, sunflower seed, watermelon seed, and peanut are the most common FBs in children in China.

In addition to acute asphyxia and dyspnea, retained airway FBs could bring about many chronic disorders such as recurrent respiratory infections, hemoptysis and even bronchiectasis.[20,21] Bonchial changes (thickening of bronchial wall, cartilage damage and fibrosis) appear when the retention of FBs is longer than 30 days.[22] We found previously the relationship between retention of FB and airway remodeling.[19] Hence, early diagnosis and management of FBA are required.

Definite history, paroxysmal coughing, stridor or wheezing, local decreased breath sounds, mediastinum swing, local emphysema or atelectasis may be helpful for the diagnosis of FBA.[23,24] However, the diagnosis of a pediatric airway FB can be difficult because FBA commonly occurs in infants and toddlers who are unable to communicate, and the above features are nonspecific and may be absent in some patients. In our 1027 patients, only 548 (53.4%) had a definite history of FBA. Furthermore, their symptoms and signs were very common in children with respiratory infections. Some patients may have obstructive lesions such as emphysema, atelectasis and airleak because of intrinsic foreign bodies including sputum plug. Therefore, complete history and clinical features are crucial in the diagnosis of FBA.

Once FBA is considered, rapid identification and localization are required. Bronchoscopy is the gold standard in the identification and localization of airway FBs. It is also an important method for the removal of FB. Although rigid bronchoscope has been the first choice for FBA, accumulated data have shown the promising value of flexible bronchoscopy in the extraction of airway FBs.[1,2,4,25] Dikensoy et al[2] reviewed the results of 457 adults with respiratory tract FB treated by flexible bronchoscopy during the 1970s to the 1990s, with a successful rate of 61%-97% (average rate: 83.6%). Recently, Ramirez-Figueroa and Swanson adopted flexible bronchoscopy on 23 and 24 children with FBA, with a high success rate of 91.3% and 100.0%, respectively.[1,4] In our unit, we used flexible bronchoscopy for FB removal with a high achievement of 91.3%.

Compared with rigid bronchoscopy, flexible bronchoscopy has many advantages. Firstly, the small diameter and flexibility make it possible to access some places which are difficult to reach by a rigid bronchoscope, such as the grade III or deeper bronchus, the left or right upper bronchus, and the basal segments

of lower bronchus. In our series, 39 patients had a history of unsuccessful rigid bronchoscopy. Secondly, flexible bronchoscopy can retrieve FB in powder or fluid, and endogenous FB (medical powder, mucus or blood plug) by vacuum aspiration or BAL, more easily than rigid bronchoscopy.[7] Thirdly, flexible bronchoscopy is also helpful for clearing local inflammatory secretion, administering drug locally, and investigating the pathogens, which might be beneficial to the control of inflammation and shortening of duration. BAL not only can wash some small fragments, powdery FBs or inflammatory section, but also is helpful for pathogen investigation, disease investigation and surveillance of BAL fluid.[26,27] Fourthly, flexible bronchoscopy is suitable for ICU patients or those with severe complications.[3,28] We performed flexible bronchoscopy through the tracheal intubation for retrieving FBs when SaO_2 was higher than 85% in 3 patients. Compared the value of flexible and rigid bronchoscopy in the management of 83 children with suspected FBA, Martinot et al concluded that flexible bronchoscopy could be the first choice.[29]

In 89 patients who turned to rigid bronchoscopy in this series, 55 patients were due to the location of FBs near the epiglottis or glottis. In the other 34 patients, FBs failed to be removed by flexible bronchoscopy because of their special features. Some FBs obstructed airways completely and left no space for basket forceps to stretch. Some FBs had too smooth surface (e.g., rubbers, nuclei of waxberry) to be clipped by biopsy forceps, some were too large to pass through the glottis or nasal cavity under a flexible bronchoscope (e.g., entire watermelon seed), and others had very sharp edges which might hurt vocal cords. Hence, rigid bronchoscopy might also be necessary for retrieving some kinds of FBs confirmed by flexible bronchoscopy.

Transient hypoxia and bradycardia during the procedure were noted in this series although they were rare, which were all alleviated immediately by oxygen supplement or rapid ending of the procedure. Mild hemoptysis and tachypnea were also noted with good outcomes. No severe events such as cardiac arrest or large hematorrhea, anesthetic complications, tracheotomy or assisted ventilation were found. Zaytoun et al[30] reported severe complications in 504 patients with FBs treated with rigid bronchoscopy, including dyspnea requiring tracheotomy or assisted ventilation, pneumothorax, and cardiac arrest.

In conlusion, flexible bronchoscopy is useful and safe in retrieving pediatric airway FBs. With skilled personnel and perfect equipments, flexible bronchoscopy could be considered as the first choice for removal of airway FBs.

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