Journal of Pediatric Surgery 55 (2020) 1860–1865

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Delayed diagnosis and surgical treatment of bronchial foreign body in children

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ARTICLE INFO

Article history:
Received 1 August 2019
Received in revised form 15 September 2019
Accepted 2 October 2019

Key words:
Bronchial foreign body
Surgery
Children

ABSTRACT

Background: Delayed diagnosis of children with Bronchial Foreign Body (BFB) leads to significant pulmonary complications and open surgery may not be avoided. However, surgical management for children with BFB is rarely reported. This study aims to describe our experience in the diagnosis and surgical treatment of late-diagnosed BFB during childhood.
Methods: Medical records of 8 children who were diagnosed with BFB and underwent open surgery at Children's Hospital of Chongqing Medical University between January 2004 and June 2019 were retrospectively reviewed.
Results: This group consisted of 8 children, with an average age of 8.1 years. In this group, the typical aspiration history was absent and the diagnosis of BFB was established in delay. The onset of diseases varied from 2 months to over 4 years. Lobectomy was performed in 7 patients and pneumonotomy was performed in 1 patient. No postoperative death was found. The clinical outcomes were satisfactory with an average 33 months follow-up.
Conclusions: The diagnosis of BFB should be considered in children who present with repeated pneumonia and agnogenic bronchiectasis and actelectasis despite repeated medical treatment. Surgical treatment is necessary and effective in patients with either unextractable BFB or irreversible damage of lung tissue.
Levels of evidence: Level IV.
Type of study: Retrospective study.

Aspiration of a foreign body is a frequent emergency condition in children and leads to potentially lethal sequelae [1]. Bronchoscopic removal of Foreign Body (FB) is the most common treatment in children with Bronchial Foreign Body (BFB) [2]. The vast majority of BFB could be removed through bronchoscopy if the diagnosis is made in an early period. However, delayed diagnosis of BFB is also observed in a large number of children [3]. Delayed diagnosis of BFB in children is generally related to pulmonary complications, such as pneumonia, actelectasis and bronchiectasis, etc. [4]. In patients with BFB and severe complications, surgical treatment may not be avoided. Therefore, in this study, we aim to describe our experience in the diagnosis and surgical treatment of late-diagnosed BFB during childhood.

1. Methods

1.1. Patient demographics

A review of the medical database at Children's Hospital of Chongqing Medical University between January 2004 and June 2019 identified 3115 consecutive patients who were diagnosed with bronchial foreign body. Of those only 8 consecutive patients underwent open surgery owing to BFB. The inclusive criteria of our study included: Patients were diagnosed with BFB who underwent open surgery. The following conditions were excluded: (1) Patients diagnosed with BFB who underwent bronchoscopy; (2) Patients who underwent open surgery and lung resection owing to other causes such as congenital pulmonary sequestration.

1.2. Diagnosis

Generally, the diagnosis of BFB could be determined with the typical aspiration history, physical examination and chest CT scan. A witnessed

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https://doi.org/10.1016/j.jpedsurg.2019.10.052
0022-3468/

episode of choking is very crucial to making a correct diagnosis of FB aspiration. However, in children with long-term repeated pneumonia and agnogenic bronchiectasis and actelectasis, despite an indeterminate history of choking and aspiration history, the diagnosis of BFB should also be suspected. In particular cases, FBs were radio-opaque and could be observed on the CT scan with high density. However, in patients with negative CT findings, the diagnosis was only confirmed by the surgical exploration. Therefore, because of the chronic nature of disease with an atypical aspiration history, the diagnosis of BFB in this group was mainly confirmed by the computer tomography (CT) scan, bronchoscopy and surgical findings.

The delayed diagnosis of BFB was defined as a time period from aspiration to the confirmed diagnosis of longer than one week [3]. However, in this group, the typical aspiration history was absent. Therefore, delayed diagnosis of BFB should be considered in patients who present with respiratory symptoms (i.e. coughing, sputum and hemoptysis) of longer than one week and eventually are diagnosed with BFB.

Tests for tuberculosis (TB) infection such as the sputum Ziehl–Neelsen stain, sputum acid-fast bacilli culture, purified protein derivative test and interferon-γ release assays were performed to exclude suspected TB.

1.3. Surgical methods

The indications for open surgery were: (1) FB could not be extracted through bronchoscopy; (2) Unexplained actelectasis or bronchiectasis with repeated infection sustained over one year despite repeated conservative management (i.e. antibiotics therapy, chest physiotherapy and bronchoscopic lavage).

Lobectomy or pneumonotomy was performed by two certified cardiothoracic surgeons at our institution. Patients were placed in lateral decubitus position and an incision through the fifth or sixth intercostal space was performed. In patients with long-term actelectasis or bronchiectasis (over three months), lobectomy should be considered when the lung tissue is no longer able to expand owing to the irreversible damage and does not contribute to ventilation which can easily lead to repeated infection. Pneumonotomy was performed in patients experiencing quick onset of disease, but still had expandable lung tissue. A chest drainage tube was inserted at the end of the surgery.

1.4. Postoperative management and follow-up

Antibiotics were given in patients with the signs of pulmonary infection. The chest drainage tube would be extracted once the daily output was less than 20 ml. Chest CT scan was conducted in every patient before discharge to evaluate the lung lesions and pleural effusion. All patients were required to return for outpatient follow-up and chest CT scan after discharge.

2. Results

2.1. Patient demographics

During a time period of 15 years, a total of 8 consecutive patients who underwent open surgery owing to BFB were identified (Table 1). This group was composed of 6 males and 2 females, with an average age of 8.1 ± 11.8 years (range 3.8–12.5 years).

The aspiration history of all 8 patients was unclear. In two patients, suspected choking history was noticed two and three years prior, respectively. The main symptoms of this group were coughing and fever. The onset of diseases varied from 2 months to over 4 years.

Seven out of eight patients were admitted to our institution for the first time. All but one (Patient #2) patient underwent repeated conservative treatment which included antibiotics and inhaled steroids and bronchodilators in other institutions. Patient #2 has been admitted to our institution for four times. He was treated by pulmonary physicians in the first three admissions. His symptoms including coughing and fever were relieved with repeated bronchial lavage and antibiotics therapy. The bronchoscopy revealed large amounts of granulation tissue at the right lower bronchus. However, no FB was found through bronchoscopy. Upon his fourth admission, he was transferred to our institution owing to severe hemoptysis. The chest CT scan indicated bronchiectasis of the right lower lobe (Fig 1), and then an emergent right lower lobectomy was performed. Dried nuts were extracted through the granulation tissue.

2.2. Imaging and bronchoscopic findings

All 8 patients underwent chest CT scan before surgery; the most common manifestation on the CT scan was actelectasis. In Patients #1,

Table 1
Baseline characteristics of included patients.

Patients	Age (years)	Gender (M/F)	Aspiration history	Latest chest CT scan	Main symptoms	Onset of diseases	Foreign body[c]
#1[a]	5	Female	Unclear	Pneumonia Actelectasis FB	Coughing fever	>2 years	Dried nuts
#2	12.5	Male	Unclear	Bronchiectasis	Coughing Fever Hemoptysis	>4 years	Dried nuts
#3[b]	6	Male	Unclear	CPC associated with infection	Coughing fever	>2 years	Pen cap
#4[a]	6.2	Male	Unclear	Pneumonia Bronchiectasis FB	Coughing fever	6 months	Diode (Toy parts)
#5[a]	3.8	Male	Unclear	Pneumonia FB	Coughing Fever Wheezing	2 months	Diode (Toy parts)
#6	7	Female	Unclear	Pneumonia Actelectasis	Coughing Fever	9 months	Plastic pieces
#7	12.3	Male	Unclear	Bronchiectasis Actelectasis	Coughing Fever	1 and half year	Whistle
#8	12.3	Male	Unclear	Actelectasis	Coughing Fever Wheezing	> 3 years	Rubber granules

FB Foreign body, *CPC* Congenital pulmonary cyst.
[a] Preoperative CT scan found high density objects in the lung tissue, therefore BFB was suspected.
[b] This patient was misdiagnosed with congenital pulmonary cyst preoperatively, however a pen cap was extracted through the resected bronchus.
[c] The types of FB were confirmed by the surgical finding.

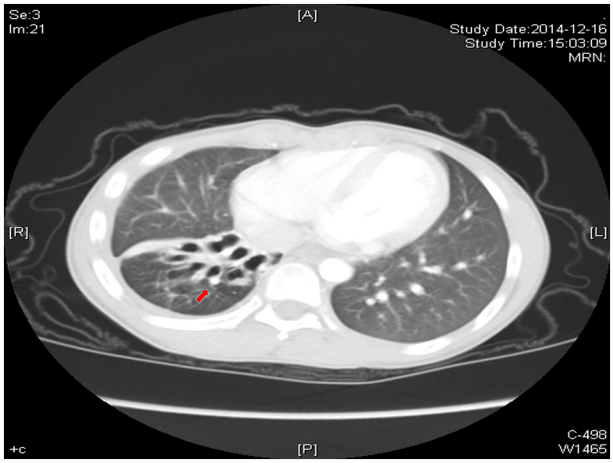


Fig. 1. The chest CT scan of Patient #2 indicates bronchiectasis of the right lower lobe and pulmonary cavity lesions (red arrow).

#4 and #5, high density objects were identified on the chest CT scan (Fig. 2). No sign of FB was detected in the rest of patients. Owing to the radiotransparent findings in other institutions, we conducted repeated chest CT scans to clarify the diagnosis. However, only nonspecific findings such as pneumonia, bronchiectasis and actelectasis were identified. The details of latest CT findings were recorded in Table 2.

All but one patient (patient#3) underwent bronchoscopy before surgery. In patients #4, #6 and #7, the FBs were found through bronchoscopy but could not be extracted. In patient #4, only a small piece of the FB was extracted through bronchoscopy. However, the main part, which was proven to be a diode after surgery (Fig. 3), penetrated into the bronchial mucosa and could not be extracted with the use of baskets, forceps or graspers. The FBs could not be extracted in both patients #6 and #7 owing to surrounding of large amount of granulation tissue. No FB was found through bronchoscopy in the rest of patients.

2.3. Surgical indications and procedures

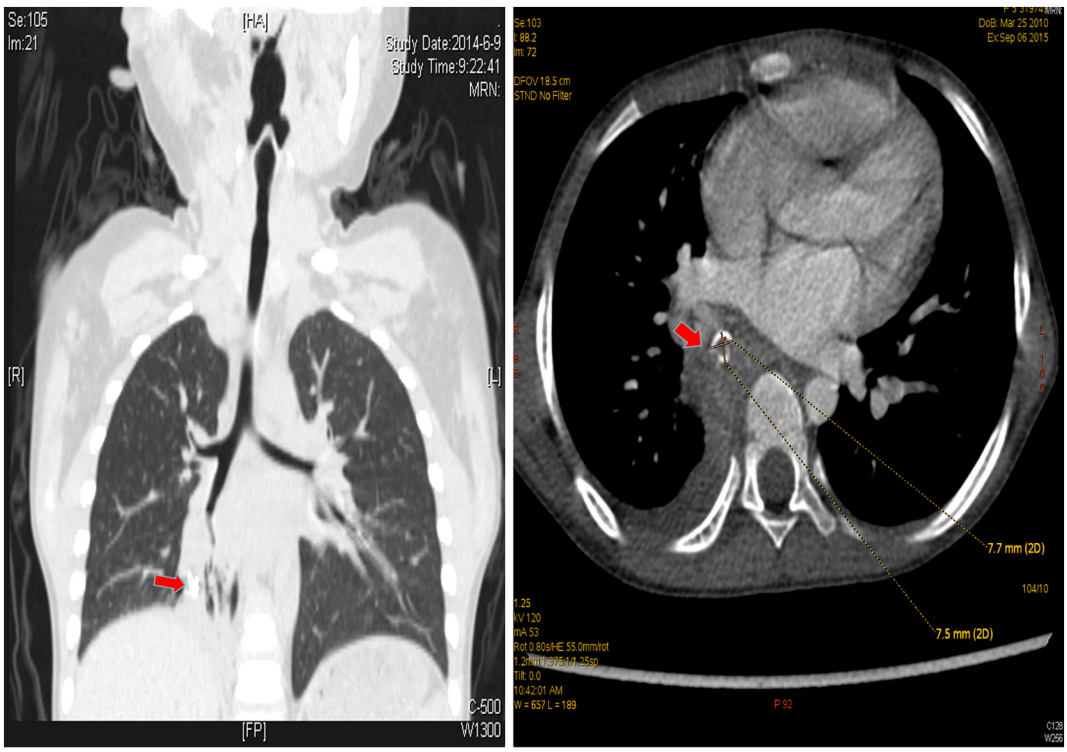
All 8 patients underwent open surgery (Table 2). The indications for surgery were failure to extract FB by bronchoscopy in Patients #4, #6 and #7. In patients #1 and #5, radio-opaque objects were found on the chest CT scan; however, no FBs were found through bronchoscopy. Therefore, thoracotomy was necessary to extract the FB. The indication for patient #3 was a misdiagnosed congenital pulmonary cyst. For the rest of patients (patients #2 and #8), surgery was indicated by confirmed actelectasis or bronchiectasis with repeated infection sustained over a one year period despite repeated conservative management.

Lobectomy was performed in seven patients, including lobectomy of the right middle and lower lobes in 2 patients (#1 and #7) and right lower lobectomy in 5 patients. In patients #1 and #7, large amount of yellowish sputum and nonexpandable middle and lower lobes were found during the surgery; therefore, the right middle and lower lobectomies were performed. In the remaining 5 patients, lobectomy was performed owing to nonexpandable and irreversible damage of the right lower lobe.

Pneumonotomy was performed in one patient (Patient #5) owing to quick onset of disease and the continued expandability of the right lower lobe. In this patient, the FB was identified at the edge of the right lower lobe (Fig. 4). And subsequent repair of incised lung tissue was conducted.

2.4. Diagnosis and postoperative management

Owing to lack of typical aspiration histories in this group, the diagnosis of BFB in all patients was established in delay (over one week) and eventually confirmed through the surgical findings. In Patients #1, #4 and #5, high density objects were identified on the chest CT scan;



A B

Fig. 2. The chest CT scan of two patients indicates signs of foreign body with high density. (A) Bronchiectasis and a high density object in the right lower lobe (red arrow). (B) Mild pleural effusion, actelectasis, and a high density object in the right lower lobe (red arrow).

Table 2
Surgical procedures, chest CT scan and bronchoscopic findings.

Patient	CT findings	Bronchoscopic findings	Surgical procedures
#1	Pneumonia, mild pleural effusion, enlarged mediastinal and hilar lymph nodes, right middle and lower lobe actelectasis, and a high density object at the right middle bronchus	Endobronchitis and no FB was found	Right middle and lower lobectomy
#2	Right lower lobe bronchiectasis and cavity lesions	Large amount of granulation tissue at the right lower bronchus and no FB was found	Right lower lobectomy
#3	Congenital pulmonary cyst associated with infection	None[a]	Left lower lobectomy
#4	Pneumonia, right lower lobe bronchiectasis and a high density object at the right lower bronchus	A metal piece was extracted, but the remaining FB penetrated into the bronchial mucosa and could not be extracted	Right lower lobectomy
#5	Pneumonia and a high density object at the right lower bronchus	Endobronchitis and no FB was found	Right lower bronchotomy
#6	Pneumonia and right lower lobe actelectasis	Large amount of granulation tissue at the right lower bronchus and FB could not be extracted	Right lower lobectomy
#7	Right middle and lower lobe actelectasis and bronchiectasis, obstruction of the right middle bronchus	Large amount of granulation tissue at the right middle bronchus and FB could not be extracted	Right middle and lower lobectomy
#8	Right lower lobe actelectasis	Endobronchitis and no FB was found	Right lower lobectomy

FB Foreign body.
[a] This patient was misdiagnosed as having congenital pulmonary cyst before surgery; therefore, bronchoscopy was not performed on him.

therefore, BFB was suspected before surgery. In patient #3, the misdiagnosis of congenital pulmonary cyst was established based on the enhanced chest CT scan (Fig. 5). However, a pen cap was extracted during the surgery and the postoperative biopsy revealed bronchiectasis and chronic pulmonary inflammation of the right lower lobe. TB infection, which was suspected in Patients #1 and #2 owing to their enlarged mediastinal and hilar lymph nodes and pulmonary cavity lesions, was excluded based on the negative TB tests.

All patients were given antibiotics after surgery. No death was found in this group. Chylothorax was observed in one patient but relieved with consistent chest drainage and fasting. No significant complication was found in the rest of patients. A chest CT scan before discharge indicated good recovery of all patients.

2.5. Follow-up

All patients returned for the outpatient follow-up. The mean follow-up time was 33.1 ± 47.7 months (range 2–48 months). No substantial pulmonary lesion or pleural effusion was found on their latest chest CT scan.

3. Discussion

BFB is a very common emergency condition in children. In our institution, which is the largest children's medical center in southwest China, an average of more than 200 patients is admitted each year with BFB. Since more than 95% patients were treated through bronchoscopy, only 8

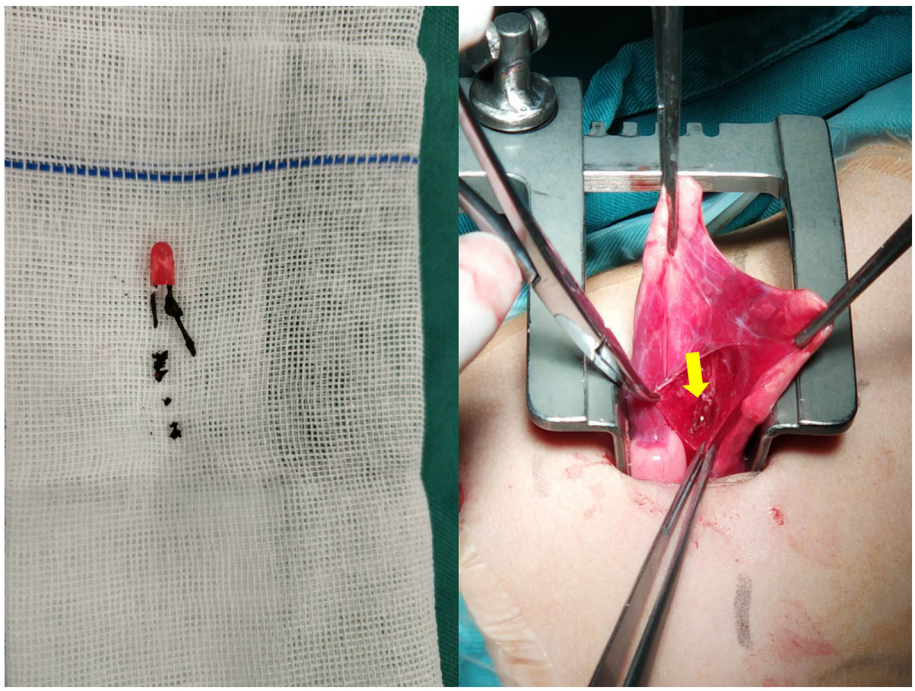


Fig. 3. A diode was found at the right lower bronchus during the bronchotomy of Patient #5 (yellow arrow).

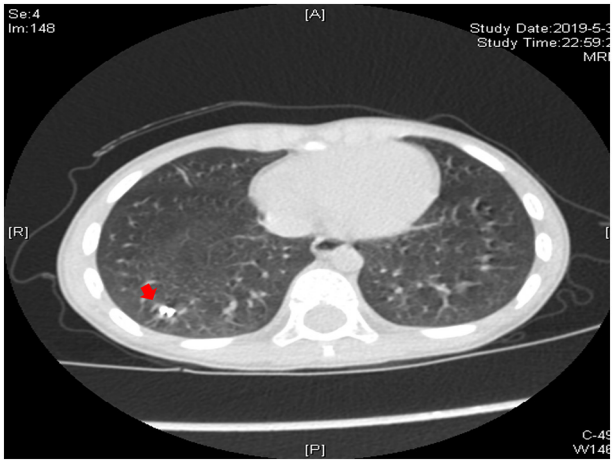


Fig. 4. A high density object is identified at the edge of the right lower lobe of Patient #5 (red arrow).

patients (8/3115) with BFB needed open surgery. When diagnosed early, most FBs were extracted through rigid- or fibrobronchoscopy or both. Surgical management is only considered when severe complications occur. Therefore, to minimize the surgical trauma, the early diagnosis and intervention are very crucial in the treatment of BFB. Traditionally, the diagnosis of BFB can be established through the aspiration history, physical examination and chest CT scan. However, in the pediatric group, the chocking history could be easily neglected or hidden. In this group, the chocking and aspiration history is not always clear and only two patients reported a suspected choking history several years prior. In our experience, there are three scenarios for neglecting or hiding chocking history: (1) Babysitters, relatives, neighbors and even parents deliberately hide the choking history to avoid being held responsible; (2) older children hide the choking history for fear of being punished; (3) choking goes unnoticed during aspiration in unattended children (i.e. 2–3 years of age) who may be likely to stuff food into their mouths. Therefore, in patients with suspected FB aspiration, repeated inquiry of choking history is necessary. Besides, repeated use of antibiotics and inhaled steroids that may mask the symptoms and reinforce the misdiagnosis also leads to a diagnostic delay [5].

The sensitivity of chest X-rays is not adequate in the diagnosis of BFB. The radio-opaque FBs only account for 3%–34.3% of all BFBs in the literature [2–4,6–9]. Therefore, in our institution, the chest X-ray is not recommended in patients with suspected BFB. Instead, a chest three dimensional reconstruction CT scan should be considered [10]. Since

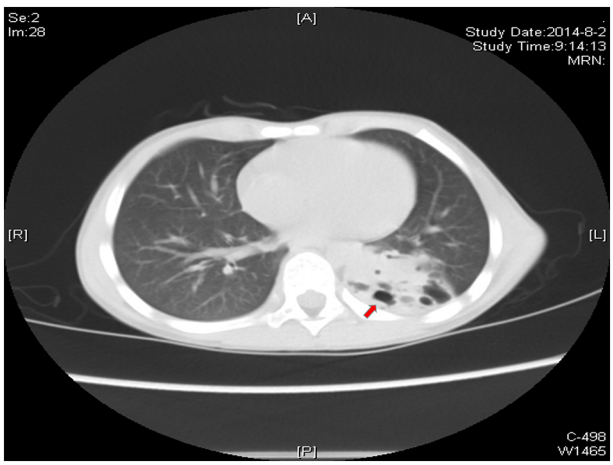


Fig. 5. The chest CT scan of Patient #3 indicates a diagnosis of congenital pulmonary cyst before surgery (red arrow).

chest CT scan is able to detect objects not observed from X-ray, it provides much more valuable information especially for those patients who are diagnosed with BFB in delay [3]. Furthermore, CT scan is also effective to evaluate the pulmonary complications such as pneumonia, bronchiectasis and actelectasis before surgery in patients with late-diagnosed BFB. Although most patients in our institution with BFB are diagnosed correctly based on their CT scan, only 3 patients are radio-opaque on the CT scan in this group. Since FBs such as food and plastics are more common in our group, the sensitivity of CT scan is not high. In patients #4 and #5, high density objects are identified on CT owing to the nature of diodes which contain metal materials. Furthermore, the foreign bodies hide in the calcification lesions and granulation tissues owing to long-term inflammation and make CT scan difficult to find the FBs. Therefore, in radiotransparent patients with agnogenic bronchiectasis or actelectasis, a negative CT scan cannot exclude the diagnosis of BFB. In our group, one patient was diagnosed with congenital pulmonary cyst before surgery; however, a pen cap was extracted through the resected bronchus. Also, the biopsy of the resected lobe revealed bronchiectasis. To our knowledge, this is the first child in the literature, who was misdiagnosed with congenital pulmonary cyst but eventually confirmed as having a BFB through surgical findings and biopsy.

In our group, use of bronchoscopy found FBs in only three patients. However, none of them could be extracted through bronchoscopy. In two patients, the FBs are surrounded by large amount of granulation tissue. When the edge of the FB is surrounded by granulation tissue, the edges are not clear so forcible removal may embed the FB deeper into the bronchus. On the other hand, the onset of diseases of these two patients is 9 months and 1.5 years, respectively. In our experience, with such a long-term period of actelectasis or bronchiectasis and repeated infection, irreversible damage of the lung tissue and surgical resection are inevitable. Therefore, after several attempts of bronchoscopic removal, we did not extract the FB forcibly through bronchoscopy. In one patient, a diode penetrates into the bronchial mucosa. Forcible bronchoscopic removal should be avoided owing to potential complications such as massive bleeding and pneumothorax [11].

In the literature, studies rarely reported the surgical management of BFB in children [3,4,6,7]. Duan et al. [3] reported the largest group (23 patients) who underwent open surgery owing to BFB. Nevertheless, only 8 patients were less than the age of 18 and no details of clinical features were presented in their pediatric group. Furthermore, no clear surgical indications for children with BFB were described in the literature. We tend to perform open surgery in the following two conditions: (1) FB cannot be extracted through bronchoscopy; (2) Actelectasis or bronchiectasis with repeated infection sustains over one year [12,13] despite repeated conservative management. Growth retardation and drop in school attendance secondary to the illness are also reported as the surgical indication [14]. Long term actelectasis or bronchiectasis with repeated infection generally leads to irreversible damage of the lung tissue. Therefore, resection of the damaged lobes which do not contribute to ventilation is necessary. The outcomes of lung resection are promising in this group; therefore, to avoid the emergence of serious pulmonary complications such as empyema and massive hemoptysis (i.e. Patient #2), surgical treatment of the damaged lobes should be performed promptly. However, in patients who are diagnosed with mild pulmonary complications without significant delay (i.e. 1–2 months), bronchoscopic removal should be attempted.

4. Conclusions

In conclusion, bronchoscopy is effective and safe to extract BFB when caught early. The delayed diagnosis of BFB should be considered in children who presented with repeated pneumonia and agnogenic bronchiectasis and actelectasis. Surgical treatment should be considered in patients with either unextractable BFB or irreversible damage of lung tissue.

Conflict of interest

None.

Ethical approval

Owing to the retrospective nature of this work, ethical approval is not required.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Funding

No funding was received.

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