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Original Article

Different types of grasping forceps in treatment of a bronchial foreign body: a comparative study in 1026 children

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Abstract: *Objective:* The goal of this study was to retrospectively analyze the characteristics of bronchial foreign bodies in children and compare utilization of different types of grasping forceps for treatment. *Methods:* Retrospective analysis of 1026 children who underwent bronchoscopy for bronchial foreign body removal at our department during 2002.6-2017.8. Under local mucosa anesthesia, electro bronchoscope and grasping forceps were operated to clear away foreign body from the airway. *Results:* In 1026 cases, food foreign body was in 927 cases (90.2%). Metal was in 2 cases. Plastic materials were in 97 cases. According to the site of foreign body, there were 316 cases in right lower lobe bronchial, 223 cases in left lower lobe, 304 cases in left or right main bronchial, 39 cases in right upper lobe, 13 cases in right middle lobe, 36 cases in left upper lobe and 27 cases in left linguist lobe. Granulation hyperplasia was found in 855 cases (83%). Only 69 cases (6.7%) experienced bronchial branch stenosis or occlusion for long disease courses. The average operation times were 1.24 ± 0.75. The one-time operation achievement ratio of patients whose foreign body obstructed the main bronchia l (100%), right lower lobe (83.2%) and left lower lobe (85.7%) was higher than others. The operation times using basket grasping forceps (1.08 ± 0.39) was lower than those using tooth types forceps (1.94 ± 1.30) and the difference was significant ($P < 0.05$), especially to massive hard nuts. *Conclusion:* In conclusion, hard nut mass and skin of melon seed was the most common type of bronchial foreign body. The right and left lower lobe bronchial and bilateral main bronchi were predilection sites, and were easier to clean out. Based on the different kinds of foreign bodies and the different sites, basket grasping forceps were significantly more effective than tooth grasping forceps.

Keywords: Children, bronchoscope, bronchial foreign body

Introduction

Foreign body in bronchus is an important pediatric respiratory disease, especial for children under ten years old [1, 2]. It is one of the major causes of persistent respiratory symptoms in children [3]. Foreign body aspiration is relatively difficult to diagnose in children [4]. Rigid bronchoscopy is considered a golden diagnostic and therapeutic method for bronchial foreign body removal [5]. Foreign bodies in airways continue to be a diagnostic and therapeutic challenge for the practicing otolaryngologists. Foreign body aspiration can result in a spectrum of presentations, from minimal symptoms [6]. The symptoms and signs produced depend upon the nature, size, location, and time since lodgment of the tracheo-bronchial foreign body.

The type of foreign body inhaled depends upon the nature of environment in which the child finds itself [7]. Vegetative foreign bodies predominate in rural areas, whereas pins and coins in urban populations. Non-organic materials include toys, pen caps, stone, marbles, balloons, etc.

Rigid bronchoscopy is the intervention of choice for the management of bronchial foreign bodies in children [5]. The ability to control the airway, ventilate, and the availability of a wide variety of

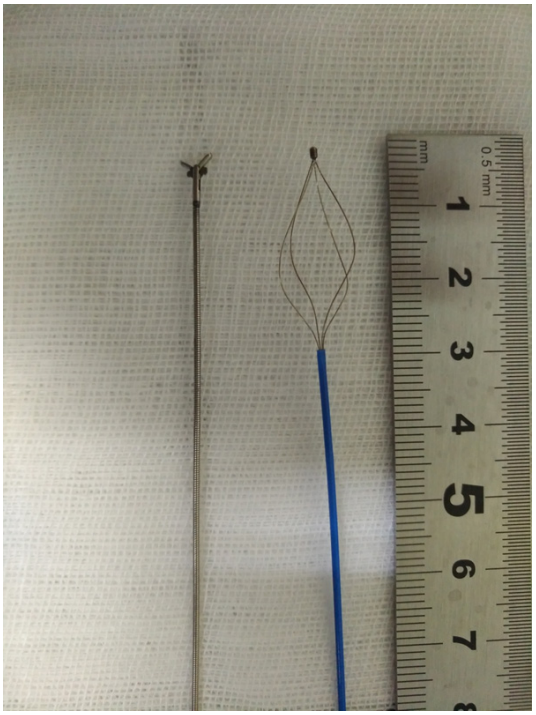

Figure 1. Tooth grasping forceps and basket grasping forceps.

extraction instruments have established rigid bronchoscopy as a safe method to remove foreign bodies in children [8]. However, foreign body extraction using rigid bronchoscopy can be difficult, especially with peanuts, because they are likely to fragment and cause tissue reaction with formation of granulation tissue. Flexible bronchoscopy has replaced rigid bronchoscopy as the diagnostic and therapeutic tool for cases with airway foreign body [9]. Flexible bronchoscopy causes less trauma and is very helpful for identifying and localizing foreign bodies because it can reach more distal bronchial regions [10]. The complex method should be used to solve this. Then under local mucosa anesthesia, electrobronchoscope and grasping forceps were operated to clear away the foreign body from the airway.

Despite the clinical significance of this problem, recent important data have not been enough. Hence, the objectives of this study were to: (1) retrospective analyze the characters of bronchial foreign body in children, (2) compare the utilization of different types grasping forceps in treatment of bronchial foreign body.

Material and methods

Objectives and patients

A retrospective review of our department data was analyzed during January 2002 to August 2017. A total of 1026 patients suffering from foreign body in bronchus, were diagnosed and treated with electronic bronchoscope.

Among those cases, boys: girls was 694:332. The youngest patient was 8 months old and the oldest one was 14 years. The average age was 1.81 ± 1.57 years. Among them, there were 864 cases (84.2%) of 1-3 years old.

The disease history lasted for 2 days to 25 months. Major clinical manifestations included persistent cough (93%), fever (56%), wheezing (34%), and hemoptysis (1.1%). History enquiry indicated in 872 cases (84.9%), the other 154 cases did not provide any complaint of foreign body aspiration. Pre-operatively, the imaging diagnosis exhibited pulmonary emphysema in 543 cases (52.9%) and mediastina displacement in 260 cases (25.3%), pneumonia complicated with pulmonary atelectasis in 312 cases (30.4%). Only 9 cases were definitely diagnosed as radiopaque foreign body by X-ray examination. Clinical diagnosis of bronchial foreign bodies was made in 872 cases before bronchoscopy.

This study was conducted in accordance with the Declaration of Helsinki. This study was conducted with approval from the Ethics Committee at Beijing Children's Hospital. Written informed consent was obtained from all participants. This study was approved by Informed Consent obtained prior to all procedures.

Bronchoscopy processes

Food and water were forbidden 6-8 hours before bronchoscopy. Atropine at the dose of 0.01-0.03 mg/kg (maximum dose ≤ 1 mg) were given 30 minutes before operation. Then, 0.2% lidocaine was sprayed three times into nasopharynx 15 minutes before the operation for nasopharynx surface anesthesia. Midazolam (at dose of 0.3 mg/kg, maximum dose ≤ 10 mg) was given by intravenous injection just before the operation via a nose insertion of the bronchoscopy to observe the airway step-by-step. When the foreign body was found, it was

Table 1. Foreign bodies and difference in foreign body forceps, the operation frequency varied among patients

Foreign body sites	Patient numbers	First-time-success rate	Operation frequency (mean ± SD)
Right upper lobe	39	31 (79.5%)	1.36 ± 0.81
Right middle lobe	13	10 (76.9%)	1.38 ± 0.77
Right lower lobe	316	263 (83.2%)	1.33 ± 0.86
Left upper lobe	36	22 (61.1%)	1.83 ± 1.27
Left lingular lobe	27	21 (77.8%)	1.52 ± 1.19
Left lower lobe	223	191 (85.7%)	1.28 ± 0.85
Left/Right main bronchi	304	304 (100%)	1.0 ± 0.00
Multi-site	68	60 (88.2%)	1.54 ± 0.87

Table 2. Operation frequency (mean ± SD) with different foreign body forceps in different types of foreign body

	Basket-forceps	Tooth-forceps	F	Sig.
Nut	1.080 ± 0.395 (679 cases)	2.241 ± 1.393 (108 cases)	314.665	< 0.001**
Nut shell	1.085 ± 0.422 (82 cases)	1.621 ± 1.090 (58 cases)	23.957	< 0.001**
Other	1.076 ± 0.311 (78 cases)	1.316 ± 0.820 (21 cases)	2.188	0.118

**means the P < 0.01, basket-forceps *vs* tooth-forceps.

grasped and removed using basket or tooth grasping forceps (**Figure 1**). Those cases complicated with bronchus infection were lavaged with normal saline after foreign body removal.

Statistical analysis

SPSS 13.0 statistical package was applied, using Rank Sum Test to analyze the data. Significant difference was defined at $P < 0.05$.

Results

Bronchoscopy findings

In the 1026 cases, the position of wedging foreign bodies included 316 cases (30.87%, the biggest percentage) at the right inferior lobe bronchus, followed by 304 cases (29.51%) at left or right primary bronchi, 223 cases (21.65%) at the left inferior lobe bronchus, 39 cases (4.1%) at the right superior lobe bronchus, 13 cases (1.26%) at the right middle lobe bronchus, 36 cases (3.5%) at the left superior lobe bronchus, and 27 cases (2.62%) at the left lingular lobe bronchus. We found multiple-site foreign bodies in 68 cases.

In the 1026 patients, there were 787 cases (76.7%) of nut matter, 140 cases (13.6%) of shells, 2 cases (0.2%) of metal foreign bodies, and 97 cases (9.6%) of other matter (including pen cap, plastic, rubber ring, etc.).

Obvious granulation hyperplasia was found in 855 cases (83%). After the foreign bodies were removed, 309 cases (30%) showed mucosa swelling and erosion, thickness secretion, complicated with infections. In 69 cases (6.7%), stenosis and occlusion were observed at deep sub-branch.

Therapeutic performance of bronchoscope

Because of influences of the varieties, positions of foreign bodies, and difference in foreign body forceps, the operation frequency varied among patients. The mean operation frequency was 1.24 ± 0.75 times, with a maximum of 6 times. The total one-time operation achievement ratio was 87.8% (901 cases). The one-time operation achievement ratio of patients whose foreign body obstructed in main bronchial is 100%, right lower lobe is 83.2% and left lower lobe is 85.7%, they were higher than others (**Table 1**).

According to different foreign body types and sites, operation times between the basket grasping forceps group and the teeth grasping forceps group were compared. The operation times using basket grasping forceps (1.08 ±

Table 3. Operation frequency (mean ± SD) with different foreign body forceps in different site

	Basket-forceps	Tooth-forceps	F	Sig.
Left/Right main bronchi	1.007 ± 0.122 (270 cases)	1.152 ± 0.567 (34 cases)	6.465	0.02*
Right upper lobe	1.125 ± 0.554 (32 cases)	2.429 ± 0.976 (7 cases)	23.736	< 0.001**
Right middle lobe	1.250 ± 0.707 (8 cases)	1.600 ± 0.894 (5 cases)	0.619	0.448
Right lower lobe	1.117 ± 0.500 (245 cases)	2.000 ± 1.249 (71 cases)	56.957	< 0.001**
Left upper lobe	1.368 ± 0.895 (19 cases)	2.353 ± 1.455 (17 cases)	6.121	0.019*
Left lingular lobe	1.111 ± 0.323 (18 cases)	2.333 ± 1.803 (9 cases)	8.067	0.029*
Left lower lobe	1.062 ± 0.304 (178 cases)	2.205 ± 1.503 (45 cases)	44.738	< 0.001**
Multi-site	1.147 ± 0.432 (66 cases)	1.000 ± < 0.001 (2 cases)	0.228	0.635

*means the P < 0.05, **means the P < 0.01, basket-forceps *vs* tooth-forceps.

0.39 times) was lower than those using tooth types forceps (1.94 ± 1.30 times). This was especially outstanding in the cases of bulk nut matter, in which the tooth foreign body forceps needed 2.24 ± 1.39 times to remove the foreign bodies while the basket forceps needed 1.08 ± 0.39 times. The difference was statistically significant (P < 0.001) (**Table 2**).

To different sites, as in left upper lobe, left lower lobe, right upper lobe and right lower lobe, basket grasping forceps was more effective to remove foreign body than tooth foreign body forceps. The difference was statistically significant (P < 0.001) (**Table 3**).

The respiratory symptoms and signs disappeared practically and imaging examination exhibited relieved pneumonia and pulmonary atelectasis a week later. That granulation tissue at the position of foreign was absorbed, the mucous membrane became smooth within 1-2 weeks. Only 69 cases (6.7%) experienced bronchial branch stenosis or occlusion for long disease courses.

Discussion

Foreign body in respiratory tract is a pediatric emergency. Of the deaths below one year old, foreign body in respiratory tract contributes 40% [11, 12]. In most cases, this disease happens to preschoolers, especially under the age of four [2]. In this research, the children younger than 3 years old took about 83.9% of all cases. Boys take a bigger part in all children suffering from this disease than girls.

Clinically, occurrence of the foreign body in airway comprised 3 periods: inhalation period, silent period, symptom and complication period [13, 14]. In most cases, the patients suffering from foreign body in bronchus may be in the silent period or even in the symptom period. They could be misdiagnosed upon first clinical visit sometimes. After a foreign body is inhaled and it blocks the bronchus, it may lead to local stimulation and secondary inflammation, partly or completely block the bronchus. Except for a clear foreign body inhalation history, cough and chocking are sensitive parameters. Stridor is specific sign [15]. Compared with tracheal foreign body, more patients with bronchial foreign body experienced decreased breath sound [4]. In this research, chronic cough and fever, wheezing were the most symptoms.

Non-invasive methods, such as fluoroscopy and CT scan, will reduce the exposing the risk of bronchoscopy and anesthesia-related complication [15, 16]. But non-radiopaque foreign body is hardly exhibited by X-ray. The imaging manifestations include obstructive emphysema, obstructive pulmonary atelectasis and pneumonia [17, 18]. In this research, nut matter or shells were found in 927 cases and these organic foods were undetectable for X-ray. Clinical representations include recurrent and position-fixed pneumonia, pulmonary atelectasis, emphysema, bronchiectasia, and lung abscess.

Flexible bronchoscopy is still the most direct and accurate method to definitely diagnose foreign body in bronchus. Local anesthesia was applied in the bronchoscopy operation of this study. The operation is safe and causes less pain to patients.

The position of a foreign body depends on its size, shape, and airflow. In our cases, the foreign bodies block the right and left main bron-

chus, right lower lobe bronchus, and left lower lobe bronchus. The results in this research indicate that the foreign body in the right and left principle bronchus, right lower lobe bronchus, or left lower lobe bronchus was easier to be removed and had a higher first-time-success rate. Foreign bodies located at left superior lobe bronchus were most difficult to get rid of. Bilateral or multipul-sitebronchial foreign body is a serious and complex case [19, 20].

According to the shape and texture of the foreign bodies, the appropriate selection of foreign body forceps can obviously improve the success rate of operation. In our research, for breakable nut matter, dentate foreign body forceps often break the foreign body and leads to the need to repeat the clamping process. While the basket foreign body forceps can fetch a whole nut matter and remove it. The dentate foreign body forceps was suited for removing those flaky foreign bodies like sunflower seed. The statistical comparison in this research suggests that application of basket foreign body forceps in fetching nut matters out reduces the number of operations significantly, compared to dentate foreign body forceps. Basket grasping forceps was easy to remove foreign body than tooth foreign body forceps in left upper lobe, left lower lobe, right upper lobe, and right lower lobe. Crytherapy and balloon dilation would be a useful maneuver in difficult cases (such as thumbtack or ballpoint pen cap) [21].

Favorable prognosis of foreign body in bronchus of children is provided after foreign body removal in most case. Few cases are available concerning surgical treatment. For most patients in this research, the clinical symptoms got relieved after the foreign bodies were removed clearly. The respiratory symptoms and signs disappeared practically and imaging examination exhibited relieved pneumonia and pulmonary atelectasis one week later.

Local granuloma formation was the common complications of bronchial foreign body. The foreign body surface smoothness and retention time were risk factors of granuloma formation [22]. In our research, it was observed that granulation tissue at the position of foreign was absorbed practically after foreign body removal. Only 16 patients with granulation tissue adhesion need to clean up with biopsy forceps. Long-standing foreign body would cause chronic respiratory symptom and irreversible bronchial damage [23]. Only 69 cases (6.7%) experienced bronchial branch stenosis or occlusion for long disease courses in this research.

Foreign body aspiration is a risky condition particularly for children under the age of three. It should be suggested to clinician to suspect bronchial foreign body aspiration when the child suffering from persistent cough, wheezing, chronic pneumonia, and pulmonary atelectasis, or obstructive emphysema in radiologic imaging. Bronchoscopy is the golden index for diagnosis and the most safe treatment method for foreign body removal. The use of a suitable type of forceps would improve the success rate of operation.

Disclosure of conflict of interest

None.

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