

Clinical analysis of tracheobronchial foreign body aspiration in children: A focus on external and intrinsic factors

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Abstract

Background

To judge the external factors and intrinsic factors affecting clinical feature of TFBA in west China and propose potential effective intervention measures.

Methods: We retrospectively analyzed the clinical data of pediatric patients diagnosed with TFBA and removed foreign body(FBs) by rigid bronchoscopy under general anesthesia at otolaryngeal department from December 2017 to November 2018.

Results

The gender constituent ratio of male(72) to female(53) was 1.4:1. The patients aged from 1 to 3 years accounting for 76% (95/125). Cough, continuous fever and **dyspnea** were premier symptoms. Right primary bronchus was the most common position involved where FBs were detected by rigid bronchoscopy in 67 cases(53.6%). Organic foreign bodies were commonest in our study. The guardians of patients between rural(parents 16, grandparents 31) and urban(parents 52, grandparents 26) group were significantly different($\chi^2=12.583$, $p=0.000$). More children were paid attention delayedly over 72 hours in rural group than urban. More children in group of no history of foreign body aspiration(12, 25%) were treated over 72 hours than in the contrary group.

Conclusion

Pediatric tracheobronchial foreign body aspiration is a kind of common emergency in otolaryngology. Age, gender, tracheobronchial anatomy and other physiological elements were defined as intrinsic factors, while guardians, residence, FBs species and prehospital time were defined as external factors of TFBA. External factors would determine the morbidity, and intrinsic factors would determine patient's condition and mortality. It is very important to take effective measures to control external factors, which was expected to decrease morbidity and mortality.

1. Background

Pediatric tracheobronchial foreign body aspiration (TFBA) is the most hazardous and most common emergency in respiratory tract diseases; it not only initiates infection but also causes obstructive asphyxia or spasmodic asphyxia [1]. The 2008 statistics from the National Safety Council (NSC) revealed that over 17 thousand pediatric patients in the United States presented to the emergency department at younger than 14, and approximately 220 patients eventually died due to TFBA in that year alone[2]. Hence, it is extremely important for patients to see an emergency medicine specialist on time and receive professional treatment if they are considered to be suffering from this kind of disease. However, when and whether children should be taken to the hospital depends on multiple factors relating to guardians, such as economic status, **geographical location**, education degree and disease cognition. West China is

characterized by mountainous areas that have less developed infrastructure and economics than East area. We analyzed the clinical data to judge the external factors and intrinsic factors affecting clinical features of TFBA in this area. The external factors referred to the living environment, and the intrinsic factors referred to physiological factors such as age and [tracheobronchial](#) anatomy.

2. Methods

This study was approved by the Institutional Review Board of the West China Hospital and performed at the West China Hospital National Diagnosis and Treatment Center of West China for Emergency and Critical Disease(NO. 2017-448). We retrospectively analyzed the clinical data of pediatric patients diagnosed with TFBA and removed foreign bodies (FBs) by rigid bronchoscopy under general anesthesia at the otolaryngeal department from December 2017 to November 2018. Owing to the development of the respiratory tract and physiological function, older children manifest more potential safety risks than infants do. Thus, we enrolled children younger than 7 years who were below the first grade of primary school and who had been diagnosed with TFBA by computed tomography (CT) scan, auscultation, symptoms and history of foreign body aspiration, which was further verified by rigid bronchoscopy. The clinical data we collected consisted of demographics (age distribution, gender), residence (rural, urban), guardian (parents, grandparents), aspiration history (witnessed or not, length of time before treatment), symptoms, bronchoscopy findings and types of foreign bodies. Statistically, qualitative data or proportions were analyzed by Fisher's exact test or Pearson's chi-squared test. In our study, qualitative data were the sample quantity in subgroups divided according to different demographics (age distribution, gender), residence (rural, urban), guardian (parents, grandparents), aspiration history (witnessed or not, length of time before treatment) and types of foreign bodies.

SPSS software (version 22.0, IBM, Chicago, USA) was used to conduct statistical analysis. $P < 0.05$ (two tailed) was considered statistically significant.

3. Results

3.1. Patient demographics

In total, 125 pediatric patients diagnosed with TFBA and treated by rigid bronchoscopy under general anesthesia at the otolaryngeal department of the West China Hospital from December 2017 to November 2018 were enrolled in our study. The gender constituent ratio of males (72) to females (53) was 1.4:1. The age distribution ranged from 7 months to 6 years with a mean age of 2.02 ± 1.13 years; patients younger than 1 year accounted for 11.2% (14/125), 1 to 3 years accounted for 76% (95/125), and older than 3 years accounted for 12.8% (16/125) (Table 1).

3.2. Clinical manifestation

According to clinical symptoms, 114 patients suffered from cough as a major symptom (91.2%), 72 patients suffered from bucking as major discomfort (57.6%), 56 patients suffered from continuous fever

(44.8%), 48 children had [dyspnea](#) as the most distressing symptom (38.4%), and 46 pediatric patients endured obvious wheezing (36.8%) (Table 1). Regarding the location of the FBs, the right primary bronchus was the most common position involved, with FBs detected by rigid bronchoscopy in 67 cases (53.6%), followed by the left primary bronchus (49/125, 39.2%) and trachea (9/125, 7.2%). The foreign body was successfully removed in 125 cases, and the location of the foreign body was consistent with the preoperative imaging examination (Table 1). Position variance of FBs in 3 cases was observed during operation from the right bronchus to the left bronchus.

3.3. Types of foreign bodies

Diverse kinds of FBs were documented in our study. In decreasing sequence, they were peanuts (51, 40.8%), sunflower seeds (32, 25.6%, 18 cases with only the shell, and 14 cases with both the shell and the seed), walnuts (23, 18.4%), rice or noodle (13, 10.4%), sarcocarp (4, 3.2%), and metal and plastics (0.8%) (Table 2).

3.4. Prehospital elements

In terms of residence, 47 patients lived in rural areas (37.6%), while 78 patients lived in urban areas (62.4%). Regarding guardians, 68 children were cared for daily by parents (54.4%); however, 57 were cared for by grandparents (45.6%). It was inquired of all patients whether the foreign body had been inhaled while eating or playing with the object in the child's mouth. The longest prehospital time after FB aspiration was 17 days, and the shortest prehospital time was 0.5 hours; 72 patients (57.6%) were brought to the hospital within one day, 36 patients between 1 and 3 days (28.8%), and 17 patients after more than 3 days (13.6%) (Table 1).

Between urban and rural children, the most common FBs were peanuts (31 vs 20), sunflower seeds (20 vs 12), and walnuts (15 vs 8); no difference was significant ($\chi^2=2.580$, $p=0.946>0.05$). The ratio of gender between the rural (female 40, male 19) and urban (female 32, male 34) groups was not significantly different ($\chi^2=0.934$, $p=0.362$). The guardians of patients between rural (parents 16, grandparents 31) and urban (parents 52, grandparents 26) groups were significantly different ($\chi^2=12.583$, $p=0.000$). The prehospital time after FB aspiration between rural (<24 h, 32; 24-72 h, 7; ≥ 72 h, 8) and urban (<24 h, 40; 24-72 h, 29; ≥ 72 h, 9) groups were significantly different ($\chi^2=7.144$, $p=0.028$). Although most patients in both groups were taken to the doctor within 24 hours, more children were treated from 24 to 72 hours in the urban group than in the rural group (29/78 vs 7/47), and fewer children were treated after over 72 hours in the urban group than in the rural group (9/78 vs 8/47) (Table 3).

When we divided pediatric patients into two groups according to their accompanying history of foreign body aspiration, there was a significant difference between the two groups about when to see a doctor ($\chi^2=11.573$, $p=0.003$). Although most patients in both groups were sent to the [pediatric clinic or emergency room](#) within 24 hours, more children in the group without foreign body aspiration (12, 25%) were treated after over 72 hours than in the contrary group (5, 6.5%) (Table 4).

4. Discussion

Pediatric TFBA refers to children who suffer from aspiration of a variety of objects by mistake while crying, smiling or yelling. It is very important to turn to specialists for professional aid immediately after aspiration occurs or to avoid it from the very beginning. In our opinion, the occurrence of TFBA was influenced by some external factors and intrinsic factors. Here, we aim to discuss these factors and search for some potentially effective measures corresponding to these factors.

Physiological elements of children were defined as intrinsic factors, including age, gender, tracheobronchial anatomy and symptoms. **Accordingly**, elements irrelevant to children were defined as external factors, including guardians, residence, type of FB and prehospital time.

Owing to both the laryngeal protective function and masticatory function development, TFBA usually occurs in infants, especially those less than 3 years old[3]. In our study, the age distribution of pediatric patients was mostly from 1 to 3 years, coinciding with Arias's findings from the National Center for Health Statistics[4]. In addition, there were 72 boys and 53 girls enrolled in our study, and the **male-female ratio** was 1.36, similar to that in Maha's study[5]. As is well known, infants attempt to explore the world with their tongues and mouths, and boys almost always show stronger curiosity and relative hyperactivity than girls in daily life. Therefore, we must emphasize time and again to guardians that infants are not permitted to eat nuts. It is best to put nuts and tiny objects out of children's sight and reach.

In regard to **bronchial anatomy**, which would affect the movement track of FBs, the right primary bronchus is steeper and wider than the left side [6]. As a result, the occurrence rate of right bronchial foreign bodies is higher than that of other types[7]. Foreign bodies in our study were mostly located in the right bronchus, followed by the left bronchus and trachea. The tracheal foreign body was fatal despite a low incidence of morbidity. Sometimes, foreign bodies would migrate after violent coughing or patting the back. Position variance of FBs in 3 patients was observed during operation from the right bronchus to the left bronchus.

Cough, bucking and having a fever were the three symptoms of highest incidence in our patients, not only because of infection but also because of rejecting reaction. The symptoms mainly depended upon the prehospital duration and the type of FB. Tan et al summarized that nuts and seeds, with some geographic and seasonal variations, were the most common FBs[8]. In our group, most of the FBs were organic objects, such as peanuts, sunflower seeds and walnuts, which produce unsaturated fatty acid and thus promote inflammation of airway mucosa.

Most of western China is mountainous, and rural and urban districts are different in terms of infrastructure and economic conditions. We regard the regional difference as an external factor of TFBA. When the patients were divided into two groups according to their residence, we found that there was a significant difference in the guardians and medical history time but not in the gender of patients or the composition of the types of FBs.

Guardians were mostly grandparents in rural areas because some parents in rural areas migrated to urban districts to hunt for jobs, leaving children to be cared for by the parents' parents. However, some parents also took children with them into urban districts, leading to fewer children living in villages and fewer patients with TFBA from rural areas. In our study, more pediatric patients were from urban areas, and more ill children were cared for by grandparents in rural areas. Therefore, in addition to providing information for parents, we must also pay attention to grandparents, especially in rural families.

Administering TFBA therapy as soon as possible upon arrival at the hospital is key to timely diagnosis and surgery [9]. However, Foltran et al found that approximately 40% of patients were given delayed diagnosis and treatment [10], and more than 72 hours of prehospital time was considered to potentially increase the risk of complications such as pneumonia, atelectasis, pneumorrhachis, pneumothorax, subcutaneous emphysema and pneumomediastinum[11].

When we focused on medical history time, we found that there were some significant differences between children with or without a history of FB aspiration. A total of 67.5% of pediatric patients with a history of FB aspiration were immediately dealt within 24 hours, while 58.3% of patients who had no explicit medical history were treated after 24 hours. Meanwhile, children living in different districts also showed differences in prehospital time. Although most patients in both groups were taken to the doctor within 24 hours, more children were not treated for over 72 hours in the rural group than in the urban group. Guardians in rural areas were mostly grandparents, who possibly spend inadequate time caring for children and showed a lack of understanding about . Along with distance from medical centers or competent hospitals, the type of guardian is responsible for delayed diagnosis or therapy.

As a result, it is crucial for the guardian to be aware of the danger of TFBA, which could reduce its incidence and prevent medical delay.

5. Conclusion

Pediatric tracheobronchial foreign body aspiration is a common emergency in otolaryngology. Age, gender, tracheobronchial anatomy and other physiological elements were defined as intrinsic factors, while guardians, residence, type of FB and prehospital time were defined as external factors of TFBA. External factors determine morbidity, and intrinsic factors determine the patient's condition and mortality. It is very important to take effective measures to control external factors, which is expected to decrease morbidity and mortality.

Abbreviations

FB: foreign body; TFBA: tracheobronchial foreign body aspiration; NSC: National Safety Council; CT: computed tomography

Declarations

Acknowledgement

Not applicable.

Authorship contribution

WG and NX were responsible for the data and sample collection and paper writing; YF and JH were responsible for surgery; DZ was responsible for data analysis; SL and JZ were responsible for the whole study design and paper revision.

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Availability of data and materials

The dataset used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

TABLE 1. Demographics and clinical characteristics of the study cohorts

	Quantity	
	No.	Proportion (%)
Gender		
male	72	57.6
female	53	42.4
Age (month)		
≤12	14	11.2
13-36	95	76.0
>36	16	12.8
Prehospital time (h)		
<24	72	57.6
24-72	36	28.8
≥72	17	13.6
Types of foreign bodies		
peanuts	51	40.8
sunflower seeds	32	25.6
walnut seeds	23	18.4
rice and noodles	13	10.4
sarcocarp	4	3.2
metal	1	0.8
plastics	1	0.8
Foreign body locations		
left primary bronchus	49	39.2
right primary bronchus	67	53.6
trachea	9	7.2
Clinical symptoms		
coughing	114	91.2
heaving	72	57.6
fever	56	44.8
dyspnea	48	38.4

wheezing	46	36.8
Residences		
rural	47	37.6
urban	78	62.4
Guardians		
parents	68	54.4
grand parents	57	45.6

TABLE 2. Composition ratio of the types of foreign bodies between urban and rural children (n,%)

Types of FBs	urban		rural		count	
	n	%	n	%	n	%
peanuts	31	39.8	20	42.6	51	40.8
sunflower seeds	20	25.6	12	25.6	32	25.6
walnuts	15	19.2	8	17.0	23	18.4
rice and noodle	8	10.3	5	10.6	13	10.4
sarcocarp	3	3.8	1	2.1	4	3.2
metal	1	1.3	0	0	1	0.8
plastics	0	0	1	2.1	1	0.8
Count	78	100	47	100	125	100

$\chi^2=2.580, p=0.946>0.05$

TABLE 3. Differences in gender, guardians and prehospital time between the two groups (n)

Residence	gender		caregivers		prehospital time (h)		
	female	male	parents	grandparents	<24	24-72	≥72
urban	32	19	52	26	40	29	9
rural	40	34	16	31	32	7	8
count	72	53	68	57	72	36	17
χ^2	0.934		12.583		7.144		
<i>P</i>	0.362		0.000		0.028*		

TABLE 4. Prehospital time after FB aspiration between two groups (n, %)

prehospital time(h)	with history		without history		count	
<24	52	67.5	20	41.7	72	57.6
24-72	20	26.0	16	33.3	36	28.8
≥72	5	6.5	12	25.0	17	13.6
count	77	100	48	100	125	100

$\chi^2=11.573, p=0.003<0.05$, History=history of FB aspiration.