

# Risk factor analysis of bronchospasm after tracheobronchial foreign body removal

## Cases report and literature review (STROBE)

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### Abstract

This retrospective study aimed to investigate bronchospasm after tracheobronchial foreign body removal. Bronchoscopy is the main clinical treatment for removing airway foreign bodies, but postoperative airway spasm is very common. In our study, we perform a risk factor analysis of bronchospasm after tracheobronchial foreign body removal. The sample was composed of 261 children with airway foreign bodies who had undergone clinical bronchoscopy for foreign body removal under general anesthesia were enrolled from the department of otolaryngology, the First Hospital of Jilin University from 2014 to 2019, of which 78 in the left bronchus, 107 in the right bronchus, 51 in the main bronchus, and 25 in the subglottis. All patients were confirmed by radiographic examination or pulmonary auscultation. All their medical records and clinical data were retrospectively analyzed; single factor and multiple factor analyses of bronchospasm were performed. The logistic regression analysis showed that age, foreign body retention time and operation time were independent risk factors for postoperative airway spasm. A history of pneumonia was not an independent risk factor for postoperative airway spasm. We should pay more attention in the preoperative period according to the specific situation of child; the right means of anesthesia and appropriate hormonal drugs should be chosen to prevent the occurrence of postoperative airway spasm.

**Abbreviations:** F = female, M = male, N = no, W = week, Y = yes.

**Keywords:** airway foreign bodies, bronchospasm, tracheobronchial foreign bodies removal

## 1. Introduction

Airway foreign bodies are a common clinically critical condition that usually refers to aspiration of the larynx or trachea or bronchial foreign bodies,<sup>[1]</sup> which are common in children under the age of 3.<sup>[2–4]</sup> The main reason is that the infantile cough reflex is not yet perfect, and eating or playing with solid objects in their mouths often causes foreign body to be aspirated into or choked

on the trachea; the most common foreign bodies are peanuts, melon seeds, and walnut plants.<sup>[5,6]</sup> Rigid bronchoscopes are the preferred instruments of choice for removal of foreign bodies. While the rigid bronchoscope can stimulate the larynx and airway more easily and induce laryngeal spasm and airway spasm, which is the most common complication.<sup>[7]</sup> Airway spasm mainly manifests as asthma, dyspnea, etc. In addition, it can develop into hypoxia and hypercapnia clinically and even be life-threatening in severe cases.

To further understand the cause of bronchial foreign bodies, the related risk factors for postoperative airway spasm provide a favorable basis for prevention and treatment. This study retrospectively analyzed the clinical data of 261 children who underwent bronchoscopy for the removal of foreign bodies to explore the risk factors for postoperative airway spasm after tracheobronchial foreign body removal.

## 2. Methods

A total of 261 children with airway foreign bodies who had undergone clinical bronchoscopy for foreign body removal under general anesthesia in our department in the past 5 years were selected. Their medical records and clinical data were retrospectively analyzed. These patients did not have preoperative III to IV degree of breathing difficulties. The exclusion criteria were as follows:

1. incomplete clinical data; and
2. preoperative airway spasm, laryngospasm or other postoperative complications.

There were 180 males and 81 females, ranging in age from 0.6 to 7 years, with an average age of  $3.12 \pm 1.84$  years. The foreign

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body locations were as follows: 78 in the left bronchus, 107 in the right bronchus, 51 in the main bronchus, and 25 in the subglottis. The study was approved by the ethics committee of The First Hospital of Jilin University. Patient consents were obtained.

The children were given sevoflurane inhalation anesthesia in the operating room; after the anesthesia took effect, a venous pathway was established, and airway hyperresponsiveness was assessed. Intravenous dexamethasone 0.5 mg/kg was provided, then the patients were switched to 1  $\mu$ g/kg intravenous anesthesia fentanyl and propofol 3.5 mg/kg, while retaining spontaneous breathing until the bronchoscope glottis area, and 2% lidocaine was applied for subglottic anesthesia intraoperatively with the use of high-flow oxygen. Sex, age, history of pneumonia, type of foreign body, duration of foreign body retention, duration of operation, and intraoperative hypoxia and ventilation were recorded.

For the children with postoperative airway spasm, the lower jaw was lifted with one hand, 5 mg of dexamethasone was given intravenously, the children were intubated through the mouth for anesthesia, and albuterol was used as an endotracheal spray; the children were extubated after recovering well.

In this study, SPSS 18.0 was used for statistical analysis. The data were normally distributed, and the related factors were described as percentages; the measurement data were tested by the  $\chi^2$  test, and a multivariate logistic regression analysis was performed. When  $P < .05$ , the difference was statistically significant.

### 3. Results

Univariate analysis of 2 groups of related risk factors: Through single-factor analysis, sex, foreign body type, intraoperative anoxia status and ventilation mode did not affect postoperative

airway spasm, and there were no significant differences between groups ( $P > .05$ ). Postoperative airway spasm were related to age, history of pneumonia, foreign body retention time and operation time ( $P < .05$ ), as shown in Table 1.

Logistic regression analysis of children in the airway spasm group: The logistic regression analysis showed that age, foreign body retention time and operation time were independent risk factors for postoperative airway spasm ( $P < .05$ ). A history of pneumonia was not an independent risk factor for postoperative airway spasm, and there was no significant difference between groups ( $P > .05$ ), as shown in Table 2.

### 4. Discussion

Inhalation of tracheal foreign bodies and bronchial foreign bodies is the most common cause of death in children with acute asphyxia. Rigid bronchoscopy is the first choice for these cases, especially in the treatment of critical cases, it can quickly and effectively relieve dyspnea. Flexible bronchoscopy is usually used through an endobronchial tube or laryngeal mask airway to remove foreign bodies, but rigid bronchoscopy must be kept on stand by.<sup>[7]</sup> Rigid bronchoscopy can easily stimulate the larynx and airway, and induce laryngospasm and airway spasm, so it requires strict requirements for anesthesia. Meanwhile, surgical operation and anesthesia management share the same airway, which makes anesthesia management more difficult. Since most patients are children, anesthetic drugs are usually selected to ensure quick effects and short anesthesia times so that the children can recover quickly from anesthesia. As the depth of anesthesia gradually decreases and the trachea is stimulated by bronchoscope friction, laryngospasm and bronchospasm are likely to occur, causing hypoxia, dyspnea and other symptoms, which may endanger the life of the child in serious cases.<sup>[8]</sup>

**Table 1**  
Univariate analysis of airway spasm.

Factors	Airway spasm group (n=46) [(n)%]	Control group (n=215) [(n)%]	$\chi^2$	P
Sex				
M	36 (78.26)	144 (66.98)	2.254	.133
F	10 (21.74)	71 (33.02)		
Age				
$\leq 1$	23 (50.00)	37 (17.21)	16.020	.000
3–4	16 (34.78)	125 (58.14)		
$\geq 5$	7 (15.22)	53 (24.65)		
History of pneumonia				
Y	31 (67.39)	95 (44.19)	8.172	.004
N	15 (32.61)	120 (55.81)		
Foreign body type				
Plants	40 (86.96)	170 (79.07)	1.499	.221
Not plants	6 (13.04)	45 (20.93)		
Foreign body retention time				
$< 1W$	9 (19.56)	143 (66.51)	34.337	.000
$\geq 1W$	37 (80.44)	72 (33.49)		
Operation time				
$< 30$ min	10 (21.74)	185 (86.05)	82.943	.000
$\geq 30$ min	36 (78.26)	30 (13.95)		
Anoxia during the operation				
Y	28 (60.87)	114 (53.02)	0.940	.332
N	18 (39.13)	101 (46.98)		
Ventilation method				
Controlled ventilation	29 (63.04)	103 (47.91)	3.473	.062
Independent ventilation	17 (36.96)	112 (52.09)		

**Table 2****Logistic regression analysis of children in the airway spasm group.**

Variable	Coefficient	Wals	P	OR	(95%CI)
Age	1.180	11.320	.001	3.254	1.637–6.472
History of pneumonia	0.721	2.223	.136	2.056	0.797–5.301
Foreign body retention time	−2.787	24.620	.000	0.062	0.020–0.185
Operation time	−3.552	42.913	.000	0.029	0.010–0.083

Therefore, it is of great clinical significance to analyze the risk factors of airway spasm after the removal of foreign bodies with bronchoscopy.

Airway spasm is not an independent disease but a functional state. Related studies have shown that there are many factors influencing the occurrence of airway spasm.<sup>[9]</sup> In this study, univariate analysis showed that age, history of pneumonia, duration of foreign body retention and operation time were all related to the occurrence of airway spasm. Age, duration of foreign body retention and operation time were independent risk factors for airway spasm. Airway foreign bodies are more common in children under 3 years old than in older children. The reason is that these children's teeth have not fully developed at this stage, so they cannot chew hard food. In addition, the protective function of the larynx is poor. In addition, the younger the age of the child, the smaller the inner diameter of the airway is, which causes stronger bronchoscope stimulation of the airway during the operation and a higher the possibility of airway spasm. It has been reported in the literature<sup>[10]</sup> that the incidence of airway spasm is significantly higher in children under 2 years of age. In addition, the incidence of bronchospasm is closely related to the duration of surgery, especially the duration of epidural bronchoscopy.<sup>[11,12]</sup>

In addition, proper coordination of anesthesia can create powerful conditions for operation and rescue. Our experience is as follows:

1. The anesthesiologist should be fully aware of the following conditions before surgery: the age and weight of the child, the size and type of foreign body, the location and degree of foreign body obstruction, the degree of hypoxia, and the presence of pneumothorax, mediastinal subcutaneous emphysema and other complications. At the same time, anesthesia and rescue drugs and rescue equipment should be prepared.
2. In emergency cases, the patient may not have enough time of fasting and water abstinence before surgery. Therefore, the anesthesiologist must ask the parents about the time, type and amount of the child's last feeding, assess the risk of aspiration, and prepare for the first aid to prevent aspiration;
3. No matter whether the children had respiratory distress or not, propofol combined with remifentanyl was used to maintain spontaneous respiration. However, it is necessary to avoid breath-holding and laryngopharyngeal bronchospasm due to insufficient anesthesia depth. The glottic region and the subglottic region to the level of the carina were anesthetized with 2% tetracaine solution on the surface before admission; if respiratory distress is severe enough to cause cyanosis and unconsciousness, the bronchoscope may be inserted without any intravenous anesthetic. After rapid clearance of respiratory secretions and rapid oxygen administration, most SpO<sub>2</sub> can be improved, and then the foreign body can be removed as soon as possible to relieve airway obstruction.
4. SpO<sub>2</sub> and chest undulation should be closely observed during the removal of foreign bodies, and the occurrence of

pneumothorax or mediastinal emphysema should be highly vigilant. Doctors need to watch for changes in lip color, which is often more sensitive than SpO<sub>2</sub>.

5. Even if the foreign body is successfully removed, children with respiratory distress in critical condition need to be sent to the pediatric ICU for further treatment. It is necessary to prevent the occurrence of acute pulmonary edema after operation.
6. If the patient has airway spasm after surgery, the doctor needs to use one hand to pull up the jaw.

At the same time, dexamethasone 5 mg was administered intravenously, anesthesia was intubated orally, and endotracheal spray salbutamol was administered. Extubation should be done after the child recovers well from breathing. In this group of cases, the anesthesiologists airway management technology is mature. The cases of airway spasm were treated reasonably, and no serious complications such as intraoperative and postoperative asphyxia were found.

In addition, relevant studies have shown that the longer the foreign body remains in the airway, the more severe the irritation of airway mucosa will be, and the more likely that children will develop an irritating cough. The retention of foreign bodies in the airway for a long time will increase the secretions in the airway, leading to swelling of the tracheal mucosa, which will eventually lead to persistent cough, emphysema and other symptoms. Highly persistent pulmonary infection caused by foreign bodies is often reported in the literature<sup>[13,14]</sup> and has a certain correlation with bronchospasm. However, according to the results of this study, a history of pneumonia was not a risk factor, may be related to the small sample size. In addition, our experience is that for children with a long duration of foreign body retention, such as those with lung infection symptoms, immediate surgery to remove the foreign body is not necessary; first, anti-inflammatory treatment should be provided, and the foreign bodies should be viewed under bronchoscopy again after 3 days. Postoperative observation should be performed for children with any degree of airway swelling, and the breathing condition should be monitored; treatment with assisted ventilation for a short period of time can be provided when necessary, thus lowering the chance of bronchospasm.

Above all, we need to pay more attention in the preoperative period and be prepared for treatment, but according to the specific situation of child; the right means of anesthesia should be chosen based on the experience of the anesthesiologist, and we should pay attention to controlling the intraoperative anesthetic depth while minimizing the bronchial incentives and give appropriate hormonal drugs to prevent the occurrence of postoperative airway spasm.

### Author contributions

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## References

- [1] Blanco Ramos M, Botana-Rial M, Garcia-Fontan E, et al. Update in the extraction of airway foreign bodies in adults. *J Thorac Dis* 2016;8:3452–6.
- [2] Aytac A, Yurdakul Y, Ikizler C, et al. Inhalation of foreign bodies in children. Report of 500 cases. *J Thorac Cardiovasc Surg* 1977;74: 145–51.
- [3] Weissberg D, Schwartz I. Foreign bodies in the tracheobronchial tree. *Chest* 1987;91:730–3.
- [4] McGuiert WF, Holmes KD, Feehs R, et al. Tracheobronchial foreign bodies. *Laryngoscope* 1988;98:615–8.
- [5] Elhassani NB. Tracheobronchial foreign bodies in the Middle East. A Baghdad study. *J Thorac Cardiovasc Surg* 1988;96:621–5.
- [6] Steen KH, Zimmermann T. Tracheobronchial aspiration of foreign bodies in children: a study of 94 cases. *Laryngoscope* 1990;100: 525–30.
- [7] Jaswal A, Jana U, Maiti PK. Tracheo-bronchial foreign bodies: a retrospective study and review of literature. *Indian J Otolaryngol Head Neck Surg* 2014;66:156–60.
- [8] Bedolla-Pulido TR, Bedolla-Barajas M. Spontaneous pneumomediastinum and subcutaneous emphysema associated with bronchospasm in a woman with no history of asthma. *Rev Alerg Mex* 2017;64:386–9.
- [9] Bharath K, Nandhakumar A, Singh H, et al. Post-reperfusion bronchospasm in a deceased donor liver transplant recipient: an enigma. *Indian J Anaesth* 2017;61:939–40.
- [10] Kuti BP, Kuti DK, Omole KO, et al. Prevalence and factors associated with exercise-induced bronchospasm among rural school children in Ilesa, Nigeria. *Niger Postgrad Med J* 2017;24:107–13.
- [11] Hasdiraz L, Oguzkaya F, Bilgin M, et al. Complications of bronchoscopy for foreign body removal: experience in 1,035 cases. *Ann Saudi Med* 2006;26:283–7.
- [12] Ciftci AO, Bingol-Kologlu M, Senocak ME, et al. Bronchoscopy for evaluation of foreign body aspiration in children. *J Pediatr Surg* 2003;38:1170–6.
- [13] Oguz F, Citak A, Unuvar E, et al. Airway foreign bodies in childhood. *Int J Pediatr Otorhinolaryngol* 2000;52:11–6.
- [14] Schmidt H, Manegold BC. Foreign body aspiration in children. *Surg Endosc* 2000;14:644–8.