Tracheobronchial foreign body aspiration in children: a 5-year retrospective study from Shanghai, China

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Abstract

Background

Foreign body (FB) aspiration is a common and serious problem in childhood, but little information is available about this condition in Chinese context. We aimed to characterize the clinical and epidemiological features of airway FBs in a pediatric Chinese population.

Methods

A retrospective review of medical records of children aged 0-14 years who attended with a diagnosis of FB aspiration the Shanghai Children's Hospital between 2013 and 2017 was carried out. Descriptive analysis was used to assess patient's demographics, clinical, radiographic, bronchoscopic findings, time to presentation, and characteristics of the FBs.

Results

Among the 200 patients included in the study, 92% were under 3 years of age, with a peak incidence of FB aspiration occurring between 1 and 2 years. The male to female ratio was 2.6:1. Twenty-three percent of the patients were admitted within 24 hours of the event, 40% within 1 week, 30% within 1 month, and 7% more than 1 month after aspiration. Eleven percent were laryngotracheal FBs and 89% were bronchial FBs. The most common presenting symptoms of laryngotracheal FBs were cough, dyspnea, and wheezing; those of bronchial FBs were cough, decreased air entry, and wheezing. Chest X-ray was normal in four-fifths of the children with laryngotracheal FBs, whereas most common abnormal x-ray findings in children with bronchial FBs were mediastinal shift, obstructive emphysema, and pneumonia. In children younger than 2 years FBs were more frequently found in the left bronchus, whereas in older children FBs were more frequently found in the right bronchus. Ninety-three percent of the removed FBs were organic materials such as food items and the most frequently aspirated FBs were peanuts. Flexible bronchoscopy was successfully performed in 80.5% of the patients, while rigid bronchoscopy or direct
laryngoscopy in 17.5% of the patients. Four patients were subjected to thoracic surgery and 1 died during bronchoscopy due to acute respiratory failure.

Conclusions

Tracheobronchial FBs should be suspected in children who have sudden onset of cough and wheezing episode, even when physical and radiographic evidence is absent. Flexible bronchoscopy has become the first choice in China used for FB removal from airways in children.

Background

The aspiration of a foreign body (FB) represents an important cause of morbidity and mortality during childhood. The obstruction caused by the FB may lead to difficulties with ventilation and oxygenation, resulting in significant morbidity. Hypoxic-ischemic brain injury and less commonly, pulmonary hemorrhage, are the main cause of death (1). Young children are particularly susceptible due to immature swallowing function, lack of molars leading to ineffective chewing, oral fixation or exploration, and tendency to play and move around while eating (2). It has been estimated that the vast majority of FB aspirations occur in children younger than 3 years, with a peak incidence between 1 and 2 years of age (3). FB aspiration occurred at an estimated incidence of 29.9/100,000 pediatric population and was responsible for 160 deaths in the US in 2000 (4). While the mortality of FB aspiration was typically high (a quarter of all cases) in the past century, the current mortality rates have substantially declined with the advance of modern bronchoscopy techniques (5). On those occasions when nor the family, neither the physician suspects the FB aspiration, diagnosis can be delayed until the onset of complications which might lead to chronic respiratory problems (6).

The presentation and the consequences of FB aspiration depend on the degree of airway obstruction, the location of the object, as well as on the age of the child, the type of
object, and the time elapsed since the event (7). Therefore, the classic triad of cough, wheeze, and diminished breath sounds is not always present (8). While the majority of FB aspirations are resolved spontaneously after a coughing episode or through assisted manoeuvres that assist expulsion, a small proportion of cases do arrive at the hospital either because the child has clinical symptoms and/or because of varying degrees of suspicion of the event happening among relatives or carers. Radiological chest x-ray evaluations should be conducted in patients with suspected FB aspiration. However, it is important to note that the findings may appear normal within the first 24 h and a number of FBs are radiolucent. Bronchoscopy is a useful diagnostic and therapeutic tool in patients with suspected FB aspiration (9). Laryngeal and tracheal FBs may need urgent intervention in the form of urgent bronchoscopy or laryngoscopy, while FBs in the right or left bronchus cause comparatively less airway problem (10). It has been reported that the majority of FBs in children are located in the bronchi, and laryngeal and tracheal FBs are less common (7,8). However, sizably voluminous FBs or those with sharp edges may be lodged in the larynx. Tracheal narrowing or impotent respiratory effort in infants under 1 year may predispose to laryngotracheal FBs.

There is great variability in the type of aspirated objects across different countries, contingent to cultural, regional, and feeding habits particularities in different populations. Items frequently implicated in children include food, coins, toys, and balloons. Most common FBs are organic in nature, mainly diminutive food items (11). Among these, nuts are the causative factor in 40% of cases in high-income and low-middle income countries (12).

Comparisons of FB in pediatric population between US and other countries, showed that over the past 40 years, the number of FBs patients reported in international studies was 5 times higher than in the literature reported from the US (13). Although a nationwide
survey data on pediatric airway FB aspiration in China is not available, there have been individual reports on a substantial increase in the number of pediatric patients with airway FB aspiration during the past two decades (14). Until now, only few domestic studies have offered detailed epidemiological data concerning the inhalation of FBs in children. Thus, this retrospective study aimed to assess the burden of airway FB injuries in China. Using a hospital database, we investigated the clinical and epidemiological features of FB aspirations in Chinese children who attended a major clinical hospital in Shanghai, China.

Methods
In this retrospective, single-center, cross-sectional descriptive study, we reviewed the hospital medical records of all children aged 0-14 years diagnosed with FB aspiration admitted to the Shanghai Children's Hospital, Shanghai Jiao Tong University, Shanghai, China, from January 2013 to December 2017. The following variables were abstracted for each patient in a specially designed study proforma: gender and age, the time lag between the inhalation and diagnosis, the presenting symptoms and signs, the findings of radiologic chest X-ray examination, the nature, size, and location of the inhaled FBs, the methods used for removal of the FBs, and the success of bronchoscopy procedure in removing the FBs, if performed. All data were expressed as frequency (percentage) or mean ± standard deviation (SD). The variables of interest were analyzed only in the patients with a definite diagnosis of FB aspiration using SPSS statistical software (SPSS Inc., Chicago, IL).

Results
Two hundred patients who had been diagnosed with a FB aspiration during the study period were included in the study. The average age, body height, and weight (SD) were 1.8 ± 1.3 years, 85.1 ± 11.3 cm, and 12.4 ± 3.6 kg, respectively. The age of the patients
ranged from 6 months to 11 years old. A total of 72.5% of the patients were male, and the male to female ratio of patients was about 2.6:1 (Table 1). Overall, 92% of the patients were under 3 years of age, with the peak incidence of 69% of FB aspiration occurring in children 1 to 2 years old (Figure 1). The lower incidence of FB aspiration in patients aged 3 years or older suggests that this event is rather sporadic in older children.

The FBs were lodged in the airways for varying lengths of time. The shortest time to reach the hospital was less than 1 hour, while the longest time was 6 months. Twenty-three percent of the patients presented at the hospital within 24 hours after inhaling the FB, 40% presented between 24 hours and 1 week, 30% between 1 week and 1 month, and 7% more than 1 month after aspiration (Figure 2).

Table 2 presented the clinical features including symptomatology and radiologic chest X-ray findings according to the body site of FB lodgment. The most common presenting symptoms of laryngotracheal FBs were cough (95.5%), dyspnea (72.7%), and wheezing (45.5%); those of bronchial FBs were cough (98.9%), decreased air entry (66.9%), and wheezing (52.8%). More than four-fifths (86.4%) of the patients with laryngotracheal FBs had no detectable pathological or radiological findings. In 7.3% of the patients the bronchial FBs were opaque. Indirect radiological signs were as follows: 36.5% of the examinations showed a shift of the mediastinum, 35.3% showed air-trapping on the affected side of the lung caused by the FBs (obstructive emphysema), and 23.6% showed the signs of pneumonia. Nearly one-third (32%) of the patients with bronchial FBs exhibited normal X-ray findings.

Table 3 summarized the location site frequency distribution of FBs according to the patient's age. Of all the patients, in 97 cases (46.4%) the FBs were lodged in the left bronchi, 90 (43.1%) in the right bronchi, and 22 (10.5%) in the larynx and trachea. We further analyzed the distribution of FBs localization stratified by age. We found that, in
children up to 2 years, the FBs were more frequently found in the left bronchi. However, in children aged 2 and older, the FBs were more frequently found in the right bronchi.

Table 4 showed the types of FBs and their frequency of occurrence. The majority (93.3%) of FBs in children were of organic nature, mostly food items, while inorganic FBs were less common. Almost half (43.3%) of the FBs were peanuts, followed by watermelon (13.9%) and sunflower seeds (9.8%).

FBs removal was done by rigid bronchoscopy or direct laryngoscopy in 35 cases (17.5%), and by flexible bronchoscopy in 163 cases (80.5%). Only 4 children (2.0%) were subjected to thoracic surgery. Unfortunately, there was one demise, a child who has died of cardiorespiratory arrest during the bronchoscopic procedure caused by acute complete obstruction of the FB in the trachea.

Discussion

Our findings showed that in a pediatric Chinese population, FB aspiration is more common in children under 3 years of age, with a peak incidence between 1 and 2 years, and the peanuts were the most commonly inhaled objects, findings in agreement with previously published literature. In children up to 2 years, FBs were more frequently found in the left bronchus, whereas in children aged 2 and older FBs were more frequently found in the right bronchus. The clinical presentation varied upon the type, size, location of the airway FB, with the most common symptoms being coughing, wheezing, and decreased air entry.

Age and gender distribution

In our study FB aspiration was most frequently observed in boys, consistent with previous studies. We do report, however, a slightly higher ratio, of 2.6:1 in comparison with previous reports of a male to female ratio of 2:1 (15-18). Of note, we noticed that FB aspiration did not occur in girls older than 4 years of age. The fact that the majority of FBs aspirations affects boys could be explained by their likely more impulsive nature and
adventurous games. Contrary to this trend, however, several studies reported a similar incidence of FB in both genders (19,20).

In agreement with previous literature, the vast majority (92%) of the patients were under 3 years of age, with the highest incidence (69%) of FB aspiration occurring in children 1 to 2 years old (15,21-24). The increased incidence at this young age has been attributed to several factors: 1) chewing objects as stage of normal oral development; 2) incomplete development of posterior teeth (molars) and, consequently, the food placed in the mouth is not adequately chewed; 3) engagement in various activities such as playing, running, crying, or laughing, while having various objects or food in the mouth, increasing the possibility of making a forced air inspiration; 4) anatomic particularities of the larynx during childhood, that is positioned high; and 5) inadequate control of deglutition (16,18,25). In addition, parents’ inattention or thumping children for acts of naughtiness during eating seem to be contributory (26).

**Time lag from inhalation to treatment**

The time between FB aspiration and extraction ranged from less than 1 hour to several months. Consistent with other reports (15,19,21,27), in this study, almost a quarter of presentations to hospital were within 24 hours and over 90 % within 1 month. When FB aspiration is suspected, immediate hospital admission is necessary, because a FB may suddenly dislodge from the original location, and obstruct another vital part of the airway, that could lead to death (28). Typical signs of a chronic FB inhalation are fever, purulent bronchitis, and bronchopneumonia that may be followed a pulmonary abscess (29). In this study, delay in the diagnosis of FB aspiration longer than 1 month occurred in 7% of children, which led to a considerable incidence of complications among these, such as pneumonia (40%) and pleural effusion (13%). The key to reaching an earlier diagnosis lies in a detailed history to identify risk factors, a thorough examination that elicits important
signs, and supportive X-ray findings. However, the diagnosis of FB aspiration is frequently delayed, because the child is asymptomatic, there are no definitive findings at physical examination, and neither clinical symptoms nor radiological findings are sufficiently specific and sensitive to demonstrate the presence of a FB in the bronchial tree.

**Symptoms and signs**

Clinical features depend on the type, location, and size of the FB, as well as the duration and degree of obstruction (30). FBs lodged in the proximal airways such as trachea and main bronchus are probably more prone to be acutely symptomatic than FBs located in peripheral airways. In our patients, the most frequent symptoms were cough, followed by reduced breath sounds, and wheezing, in agreement with previous reports (19,22,23,31). Overall, although all the clinical symptoms reported have a high positive predictive value for FB aspiration, all also have a relative low specificity (17,18). It should be noted that despite having a FB in the bronchial tree, a small percent (1%) of children in our study were completely asymptomatic. It was reported that even as many as 30% of the patients with FB aspiration have normal physical examinations (30,32). Thus, the absence of clinical symptoms with a positive history for FB aspiration cannot exclude the presence of a FB in the airway in a young child.

**Radiologic examinations**

To improve diagnostic accuracy above history and physical examination alone, imaging plays a key role in the initial evaluation and follow-up of possible FB aspiration. However, the value of chest radiography in making a diagnosis remains controversial. In our study, more than one-third (38%) of the patients with laryngotracheal or bronchial FBs showed normal x-ray findings. It has been reported that the percentage of patients with FB aspiration having normal chest x-ray in other retrospective studies ranged from a low of 10% (33) to a high of 46% (18). The relative high percentage of normal x-ray findings may
be related to the fact that most of the FBs were radiolucent organic objects. In our study, the common abnormal x-ray findings in the patients with bronchial FBs were mediastinal shift, obstructive emphysema, and pneumonia. Similarly, previous studies reported as most common x-ray findings mediastinal shift (19,34), air trapping (35,36), and atelectasis (37). However, it should be kept in mind that these signs are not pathognomonic, and, as a result, chest radiography alone is neither sufficiently sensitive nor specific enough method for diagnosis of FB aspiration. If history and clinical findings suggest FB aspiration, a normal chest x-ray should never deter the physician from carrying out a bronchoscopy.

**Instruments**

The most suitable technique for removing an FB in children remains controversial. Although previous studies recommended rigid bronchoscopy for extraction of FBs in children (15,16,19,20,28,31), recent studies have demonstrated the effectiveness of flexible bronchoscopy (17,18,38-40). In contrast with rigid techniques, flexible bronchoscopy offers several advantages such as the possibility to reach higher order of subsegmental bronchi and be conducted with local anesthesia, with the child under deep sedation. (38,41). The ready availability in most medical centers and the development of new pediatric flexible scopes with working channels combined with increased expertise and skills of the operators led to increased used of flexible bronchoscopy in children. (41).

At our institution, we prefer flexible bronchoscopy using local anesthesia. Transient hypoxia and tachypnea during the procedure were noted in this series although they were rare. In all cases they were immediately alleviated by oxygen supplementation or prompt ending of the procedure. It should be noted that proper training and experience is crucial to optimizing the outcome and minimizing the risk of complications in tracheobronchial FB removal. With one exception, no severe complications such as cardiac arrest, large
hematuria, and anesthetic events occurred in our cohort. A small percentage of the patients underwent rigid bronchoscopy due to the special location of the FBs (near epiglottis or glottis) and the special feature of the FBs (obstructing airways completely and leaving no space for basket forceps to reach or having a very smooth surface to be clipped by biopsy forceps). The endoscopic procedures failed to remove the FBs which were located in the basal segment of the lower lobe in 4 patients (2%), and these patients underwent surgery for removal of the FBs.

**Lodgment site**

Whereas in adults the inhaled FBs most commonly lodge in the right bronchus due to anatomy of the right and left tracheobronchial angles (42), in children, the preference of FBs location is controversial, with some studies reporting higher frequency of the FB either in the right bronchus (19,24,31,33), or in the left bronchus (9,29,43), whereas some other studies found an approximately even distribution (23,30,44). In our study, in children younger than 2 years the FBs were more frequently found in the left bronchus, but in children aged 2 and older the FBs were more frequently found in the right bronchus. The preference for FB to lodge in the left bronchus in children younger than 2 years is not clear, it might be explained by the particular anatomical changes of the bronchial tree during the playing times such as those described by Van et al. (42). Another explanation might be that in young children the left main bronchus has almost the same diameter as the right one and is not ramified at the same acute angle as in adults (45).

**Type of foreign bodies**

Our findings are in agreement with those presented by previous authors that 71% to 98% of the inhaled FBs are organic in nature (15,16,18,19,24). In our study, the vast majority of the FBs were food items. Among these, most frequently FBs encountered were peanuts, followed by watermelon and sunflower seeds, consistent with previous domestic studies
(19,38,46). However, plastic objects (toys) were not a frequent cause of FB aspiration in our study but they represented more than 10% of those identified in the developed world (47). The nature of inhaled FBs varies among countries and is largely dependent on cultural, social, and economic factors that include parental attitudes and eating habits (11).

Conclusions

In summary, we report that in a population of Chinese children, the highest incidence of FB aspiration occurs between 1 and 2 years of age, and the peanuts are the most commonly inhaled organic objects. The most common clinical presentation of airway FBs are coughing, wheezing, and decreased air entry, with the FBs most commonly located in the left bronchus. We reiterate here that absence of clinical symptoms and/or normal chest radiologic examinations with a history suggestive of potential FB aspiration should prompt the physician to perform a diagnostic bronchoscopy. Flexible bronchoscopy is safe and effective in removing airway FBs in pediatric populations.

Abbreviations

FB: foreign body
SD: standard deviation

Declarations

Acknowledgements

Not applicable.

Ethics approval and consent to participate

Written informed consent was obtained from each pediatric patient’s parent before performing bronchoscopy in clinical practice. Being a retrospective study, no consent was required for the analysis of the data retrieved from medical records. The research protocol
for this study was approved by the Medical Ethics Committee of Shanghai Children's Hospital, Shanghai Jiao Tong University.

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**Authors’ contributions**

GH and LM conceived the study and designed it with DG. DG and WB drafted the manuscript. VA provided critical comments and substantially revised the manuscript. CC collected and analyzed the clinical data. All authors read and approved the final manuscript.

**Availability of data and materials**

The datasets used during the current study are available from the corresponding author on request.

**Competing interests**

The authors declare that they have no competing interests.

**Consent for publication**

Not applicable.

**References**

1. Wu X, Wu L, Chen Z, Zhou Y. Fatal choking in infants and children treated in a pediatric intensive care unit: A 7-year experience. Int J Pediatr Otorhinolaryngol. 2018; 110:67-69.

2. Committee on Injury, Violence, and Poison Prevention. Prevention of choking among children. Pediatrics. 2010; 125(3):601-7.

3. Paksu S, Paksu MS, Kilic M, Guner SN, Baysal K, Sancak R, Ozturk F. Foreign body aspiration in childhood: evaluation of diagnostic parameters. Pediatr Emerg Care. 2012; 28(3):259-64.
4. Centers for Disease Control and Prevention (CDC). Nonfatal choking-related episodes among children--United States, 2001. MMWR Morb Mortal Wkly Rep. 2002;51(42):945-8.

5. Sultan TA, van As AB. Review of tracheobronchial foreign body aspiration in the South African paediatric age group. J Thorac Dis. 2016; 8(12):3787-96.

6. Swanson KL. Airway foreign bodies: what's new? Semin Respir Crit Care Med. 2004; 25(4):405-11.

7. Eren S, Balci AE, Dikici B, Doblan M, Eren MN. Foreign body aspiration in children: experience of 1160 cases. Ann Trop Paediatr. 2003; 23(1):31-7.

8. Tan HK, Brown K, McGill T, Kenna MA, Lund DP, Healy GB. Airway foreign bodies (FB): a 10-year review. Int J Pediatr Otorhinolaryngol. 2000; 56(2):91-9.

9. Korlacki W, Korecka K, Dzielicki J. Foreign body aspiration in children: diagnostic and therapeutic role of bronchoscopy. Pediatr Surg Int. 2011; 27(8):833-7.

10. Zaupa P, Saxena AK, Barounig A, Höllwarth ME. Management strategies in foreign-body aspiration. Indian J Pediatr. 2009; 76(2):157-61.

11. Foltran F, Ballali S, Passali FM, Kern E, Morra B, Passali GC, Berchialla P, Lauriello M, Gregori D. Foreign bodies in the airways: a meta-analysis of published papers. Int J Pediatr Otorhinolaryngol. 2012; 76 (Suppl 1):S12-9.

12. Natan Cramer, Noel Jabour, Melissa M. Tavarez, Roger S. Taylor. Foreign Body Aspiration. StatPearls [Internet]. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK531480/ Last Update: October 27, 2018.

13. Kaushal P, Brown DJ, Lander L, Brietzke S, Shah RK. Aspirated foreign bodies in pediatric patients, 1968-2010: a comparison between the United States and other countries. Int J Pediatr Otorhinolaryngol. 2011;75(10):1322-6.

14. Zhang X, Li WX, Cai YR. A time series observation of Chinese children undergoing...
rigid bronchoscopy for an inhaled foreign body: 3,149 cases in 1991-2010. Chin Med J (Engl). 2015; 128(4):504-9.

15. Schmidt H, Manegold BC. Foreign body aspiration in children. Surg Endosc. 2000; 14(7):644-8.

16. Skoulakis CE, Doxas PG, Papadakis CE, Proimios E, Christodoulou P, Bizakis JG, Velegakis GA, Mamoulakis D, Helidonis ES. Bronchoscopy for foreign body removal in children. A review and analysis of 210 cases. Int J Pediatr Otorhinolaryngol. 2000; 53(2):143-8.

17. Midulla F, Guidi R, Barbato A, Capocaccia P, Forenza N, Marseglia G, Pifferi M, Moretti C, Bonci E, De Benedictis FM. Foreign body aspiration in children. Pediatr Int. 2005; 47(6):663-8.

18. Mansour B, Elias N. Foreign Body Aspiration in Children with Focus on the Role of Flexible Bronchoscopy: A 5 Year Experience. Isr Med Assoc J. 2015; 17(10):599-603.

19. Mu L, He P, Sun D. Inhalation of foreign bodies in Chinese children: a review of 400 cases. Laryngoscope. 1991; 101(6 Pt 1):657-60.

20. Baram A, Sherzad H, Saeed S, Kakamad FH, Hamawandi AMH. Tracheobronchial Foreign Bodies in Children: The Role of Emergency Rigid Bronchoscopy. Glob Pediatr Health. 2017; 4:2333794X17743663.

21. Wolach B, Raz A, Weinberg J, Mikulski Y, Ben Ari J, Sadan N. Aspirated foreign bodies in the respiratory tract of children: eleven years experience with 127 patients. Int J Pediatr Otorhinolaryngol. 1994; 30(1):1-10.

22. Oğuzkaya F, Akçali Y, Kahraman C, Bilgin M, Sahin A. Tracheobronchial foreign body aspirations in childhood: a 10-year experience. Eur J Cardiothorac Surg. 1998; 14(4):388-92.

23. Baharloo F, Veyckemans F, Francis C, Biettlot MP, Rodenstein DO. Tracheobronchial
foreign bodies: presentation and management in children and adults. Chest. 1999; 115(5):1357-62.

24. Latifi X, Mustafa A, Hysenaj Q. Rigid tracheobronchoscopy in the management of airway foreign bodies: 10 years experience in Kosovo. Int J Pediatr Otorhinolaryngol. 2006; 70(12):2055-9.

25. Rovin JD, Rodgers BM. Pediatric foreign body aspiration. Pediatr Rev. 2000; 21(3):86-90.

26. Banerjee A, Rao KS, Khanna SK, Narayanan PS, Gupta BK, Sekar JC, Retnam CR, Nachiappan M. Laryngo-tracheo-bronchial foreign bodies in children. J Laryngol Otol. 1988; 102(11):1029-32.

27. Paşaoğlu I, Doğan R, Demircin M, Hatipoğlu A, Bozer AY. Bronchoscopic removal of foreign bodies in children: retrospective analysis of 822 cases. Thorac Cardiovasc Surg. 1991; 39(2):95-8.

28. Steen KH, Zimmermann T. Tracheobronchial aspiration of foreign bodies in children: a study of 94 cases. Laryngoscope. 1990;100(5):525-30.

29. Saquib Mallick M, Rauf Khan A, Al-Bassam A. Late presentation of tracheobronchial foreign body aspiration in children. J Trop Pediatr. 2005;51(3):145-8.

30. Laks Y, Barzilay Z. Foreign body aspiration in childhood. Pediatr Emerg Care. 1988;4(2):102-6.

31. Shivakumar AM, Naik AS, Prashanth KB, Shetty KD, Praveen DS. Tracheobronchial foreign bodies. Indian J Pediatr. 2003; 70(10):793-7.

32. Losek JD. Diagnostic difficulties of foreign body aspiration in children. Am J Emerg Med. 1990;8(4):348-50.

33. Haddadi S, Marzban S, Nemati S, Ranjbar Kiakelayeh S, Parvizi A, Heidarzadeh A. Tracheobronchial Foreign-Bodies in Children; A 7 Year Retrospective Study. Iran J
34. Liang J, Hu J, Chang H, Gao Y, Luo H, Wang Z, Zheng G, Chen F, Wang T, Yang Y, Kou X, Xu M. Tracheobronchial foreign bodies in children - a retrospective study of 2,000 cases in Northwestern China. Ther Clin Risk Manag. 2015; 11:1291-5.

35. Sink JR, Kitsko DJ, Georg MW, Winger DG, Simons JP. Predictors of Foreign Body Aspiration in Children. Otolaryngol Head Neck Surg. 2016;155(3):501-7.

36. Mortellaro VE, Iqbal C, Fu R, Curtis H, Fike FB, St Peter SD. Predictors of radiolucent foreign body aspiration. J Pediatr Surg. 2013; 48(9):1867-70.

37. Fraga Ade M, Reis MC, Zambon MP, Toro IC, Ribeiro JD, Baracat EC. Foreign body aspiration in children: clinical aspects, radiological aspects and bronchoscopic treatment. J Bras Pneumol. 2008 Feb;34(2):74-82.

38. Tang LF, Xu YC, Wang YS, Wang CF, Zhu GH, Bao XE, Lu MP, Chen LX, Chen ZM. Airway foreign body removal by flexible bronchoscopy: experience with 1027 children during 2000-2008. World J Pediatr. 2009;5(3):191-5.

39. Ramírez-Figueroa JL, Gochicoa-Rangel LG, Ramírez-San Juan DH, Vargas MH. Foreign body removal by flexible fiberoptic bronchoscopy in infants and children. Pediatr Pulmonol. 2005; 40(5):392-7.

40. Swanson KL, Prakash UB, Midthun DE, Edell ES, Utz JP, McDougall JC, Brutinell WM. Flexible bronchoscopic management of airway foreign bodies in children. Chest. 2002;121(5):1695-700.

41. Lowe DA, Vasquez R, Maniaci V. Foreign Body Aspiration in Children. Clin Pediatr Emerg Med. 2015;16(3):140-8.

42. Van Looij MA, Rood PP, Hoeve LJ, Borgstein JA. Aspirated foreign bodies in children: why are they more commonly found on the left? Clin Otolaryngol Allied Sci. 2003; 28(4):364-7.
43. Vane DW, Pritchard J, Colville CW, West KW, Eigen H, Grosfeld JL. Bronchoscopy for aspirated foreign bodies in children. Experience in 131 cases. Arch Surg. 1988;123(7):885-8.

44. Yamamoto S, Suzuki K, Itaya T, Yamamoto E, Baba S. Foreign bodies in the airway: eighteen-year retrospective study. Acta Otolaryngol. 1996; 525(Suppl):6-8.

45. Cleveland RH. Symmetry of bronchial angles in children. Radiology. 1979; 133(1):89-93.

46. Huankang Z, Kuanlin X, Xiaolin H, Witt D. Comparison between tracheal foreign body and bronchial foreign body: a review of 1,007 cases. Int J Pediatr Otorhinolaryngol. 2012;76(12):1719-25.

47. Ambrose SE, Raol NP. Pediatric airway foreign body. Oper Tech Otolaryngol Head Neck Surg. 2017; 28:265-9.

Tables

Table 1 Demographic characteristics (n = 200)

| Variables                  | Larynx and trachea (n = 22) (%) | Bronchi (n = 178) (%) | (n) |
|----------------------------|---------------------------------|-----------------------|-----|
| Gender                     |                                 |                       |     |
| Boys                       | 14 (63.6%)                      | 131 (73.6%)           | 14  |
| Girls                      | 8 (36.4%)                       | 47 (26.4%)            | 5   |
| Age (years) (mean ± SD)    | 2.0 ± 1.2                       | 1.8 ± 1.3             |     |
| Height (cm) (mean ± SD)    | 86.3 ± 11.8                     | 85.0 ± 11.3           |     |
| Weight (kg) (mean ± SD)    | 12.8 ± 3.7                      | 12.3 ± 3.6            | 1   |

Table 2 Clinical signs and laboratory findings (n = 200)
### Table 3 Lodgment site of foreign body aspiration (n = 209)\(^a\)

| Location                  | Children younger than 2 years (n = 156) (%)\(^b\) | Children aged 2 years and older (n = 53) (%)\(^b\) |
|---------------------------|--------------------------------------------------|--------------------------------------------------|
| Larynx                    | 1 (0.6%)                                          | 0 (0.0%)                                          |
| Trachea                   | 15 (9.6%)                                         | 6 (11.3%)                                         |
| Right lung                | 63                                                | 27                                                |
| Right main bronchus       | 45 (28.8%)                                        | 22 (41.5%)                                        |
| Right intermediate bronchus| 2 (1.3%)                                          | 0 (0.0%)                                          |
| Right middle bronchus     | 1 (0.6%)                                          | 0 (0.0%)                                          |
| Right lower bronchus      | 15 (9.6%)                                         | 5 (9.4%)                                          |
| Left lung                 | 77                                                | 20                                                |
| Left main bronchus        | 55 (35.3%)                                        | 14 (26.4%)                                        |
| Left upper bronchus       | 6 (3.8%)                                          | 2 (3.8%)                                          |
| Left lower bronchus       | 16 (10.3%)                                        | 4 (7.5%)                                          |

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\(^a\)More than one of these findings are present in some patients.

\(^b\)Frequency distribution (percentage) add up to 100 on the column.
Table 4 Type of foreign body aspiration (n = 194)\(^a\)

| Type of foreign body | Frequency (%)\(^b\) |
|----------------------|---------------------|
| **Organic objects**  |                     |
| Peanut               | 84 (43.3%)          |
| Walnut               | 11 (5.7%)           |
| Almond               | 8 (4.1%)            |
| Chestnut             | 6 (3.1%)            |
| Watermelon seed      | 27 (13.9%)          |
| Sunflower seed       | 19 (9.8%)           |
| Pumpkin seed         | 4 (2.1%)            |
| Bone (chicken or fish)| 7 (3.6%)           |
| Bean                 | 6 (3.1%)            |
| Shrimp               | 3 (1.5%)            |
| Sugarcane bagasse    | 2 (1.0%)            |
| Chocolate            | 2 (1.0%)            |
| Grain                | 1 (0.5%)            |
| Puffed rice          | 1 (6.7%)            |
| **Inorganic objects**|                     |
| Plastic object       | 5 (2.6%)            |
| Silver foil paper    | 2 (1.0%)            |
| Toy                  | 2 (1.0%)            |
| Pen cap (plastic or metal)| 2 (1.0%) |
| Drawing pin          | 1 (0.5%)            |
| Stone                | 1 (0.5%)            |

\(^a\)Types of the foreign bodies from 6 patients were not identified.

\(^b\)Frequency distribution (percentage) add up to 100 on the column.

Figures
Figure 1

Age and gender distribution of foreign body aspiration (n = 200).