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Rigid Bronchoscopy in Foreign Bodies Aspiration: Value of the Clinical and Radiological Findings

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ABSTRACT

Background: Foreign body aspiration (FBA) is an emergency condition in children, potentially leading to life-threatening events. The gold standard for FBA management typically involves rigid bronchoscopy (RB). Since RB is performed under general anesthesia (GA), it exposes the child to the risk of GA and perioperative complications. Therefore, the current study aimed to examine the association of clinical and radiological signs with RB results.

Methods: This cross-sectional study was conducted at Imam Reza Hospital, affiliated with Kermanshah University of Medical Sciences (KUMS), Kermanshah Province, Iran. A total of 86 children suspected of FBA were included in the study. All patients underwent RB under GA after a thorough evaluation, including a detailed medical history, physical examination, and poster anterior chest X-ray (CXR).

Results: Of 86 patients, 55 (64.0%) were male and 31 (36.0%) were female. The mean age of participants was 3.40 ± 1.41 years (1 to 7 years). The history of coughing and crepitation were the most common symptoms (100%). Among 86 patients who underwent RB, 52 (60.0%) had FBA in their airway, while 34 patients (40.0%) had negative RB results. The most frequently aspirated foreign body was sunflower seeds, observed in 25.0% of cases. The right main bronchus was identified as the most common site of the foreign bodies, accounting for 48.1%. The coughing and crepitation had a very high sensitivity of 100%, whereas hypoxemia had the highest specificity of 13.3%.

Conclusion: None of the clinical symptoms, such as coughing, demonstrated high sensitivity or specificity individually or in combination. Therefore, it is of utmost importance to educate children and parents about preventive measures to reduce the risk of FBA and to provide a comprehensive understanding of the potential consequences associated with FBA.

Keywords: Aspiration, Bronchoscopy, Chest X-ray, Iran, Symptoms

Introduction

Foreign body aspiration (FBA) is a critical emergency situation commonly encountered in pediatric patients, necessitating immediate diagnosis and early management to minimize consequences (1). While FBA mostly affects children within the age range of 1–3 years, it can also occur in older age groups. Notably, FBA ranks as the third and fourth most common cause of accidental death in children younger than 1 year old and those younger than 3 years old, respectively (2, 3). Regarding gender, FBA higher incidence in males, with a male-to-female ratio ranging from 1.5:1 to 2.4:1 (4). Seeds, food particles, hardware, and pieces of toys are commonly aspirated foreign bodies (FBs) in children (5).

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The clinical presentation of FBA can vary widely, ranging from a clinically asymptomatic condition to severe respiratory failure. The most common symptom is continuous and suffocating cough (6). The presenting symptoms of FBA depend on several factors, including the child's age, FB location, FB type, the degree of airway blockage, and the time passed since the FBA (7). Complications associated with FBA encompass a range of conditions, such as lung abscesses and bronchiectasis (8). However, in case of timely diagnosis and FB extraction, the occurrence of complications can be minimized (9).

The gold standard for FBA management is rigid bronchoscopy (RB), which serves both diagnostic and therapeutic purposes. The RB is generally performed under general anesthesia (GA) and carries potential risks associated with the anesthesia and perioperative complications, such as bronchospasm, desaturation, bleeding, and airway edema (10). Therefore, the crucial decision to perform RB should be carefully made based on clinical and radiological findings. Given the above-mentioned, the current study aimed to examine the association of clinical and radiological signs with RB results.

Methods

Setting and Design

This cross-sectional study was performed at Imam Reza Hospital, affiliated with Kermanshah University of Medical Sciences (KUMS), Kermanshah Province, Iran. With 750 active beds, this mega general hospital serves Kurdish populations ad provides comprehensive medical care to individuals regardless of their disease severity and socioeconomic status.

A total of 86 consecutive patients suspected of FBA from April 1, 2013 to March 30 2019, were enrolled in the current study. The exclusion criteria were pneumonia, asthma, infants under 6 months of age, and adolescents over 15 years of age.

The participants were referred to the hospital presenting symptoms, such as coughing, choking, and breathing sound reduction, accompanied by clinical signs, including decreased air entry, cyanosis, or crepitation. All patients underwent RB under GA following history, physical examination, and poster anterior chest X-ray (CXR).

Definitions

Sensitivity is the possibility that a truly infected person will test positive for the condition. Specificity is the possibility that a truly uninfected person will test negative. Positive predictive value (PPV) is the possibility that those testing positive by the test are truly infected. On the other hand, negative predictive value (NPV) is the possibility that those testing negative by the test are truly uninfected. Positive likelihood ratio (PLR) quantifies the increase in the probability of having a disease given a positive test result. The PLR is the possibility a person with the condition tests positive (a true positive)/possibility a person without the condition tests positive (a false positive). Negative likelihood ratio (NLR) refers to the extent to which the probability of having a disease is decreased, given a negative test result. The NLR is the possibility a person with the condition tests negative (a false negative)/ possibility a person without the condition tests negative (a true negative).

Statistical Methods

The relative frequencies of categorical variables were utilized to express the data, and a comparison between variables was conducted using the chi-square test or Fisher's exact test. Sensitivity, specificity, PPV, NPV, PLR, and NLR of the clinical and radiological signs were used to describe predictive properties. Statistical analyses were performed using SPSS software (version 23.0). Values were considered statistically significant at $P \leq 0.05$.

Ethical approval

The Research Ethics Committee at the Deputy of Research of KUMS approved the study protocol (IR.KUMS.REC. IR.KUMS.REC.1399.313.). In addition, all parents were informed about bronchoscopic intervention and its risks and signed a written consent form. Individual personal information was kept confidential.

Results

A total of 86 RB were performed under GA for diagnosis and therapeutic purposes. The age of patients ranged from 1 to 7 years, with the majority (73.3%) falling between 2-4 years of age. The mean age was 3.40±1.41 years. Of the 86 patients, 55 (64.0%) were male and 31 (36.0%) were female.

Upon clinical examination, the history of coughing and crepitation were the most common symptoms, as displayed in Table 1.

Among 86 patients who underwent RB, 52 (60.0%) had foreign body in their airway, while 34 patients (40.0%) had negative RB results.

Table 1. Relationship between RB findings and clinical & radiological signs

Characteristic	Subgroup	RB findings		P-value
		No FB	FB present	
Coughing	Absent	0(0)	0(0)	1.0
	Present	34(100)	52 (100)	
Crepitation	Absent	0(0)	0(0)	1.0
	Present	34(100)	52 (100)	
Wheezing	Absent	0(0)	2(4.0)	0.247
	Present	34(100)	50(96.0)	
Breathing sound reduction	Absent	0(0)	6(11.5)	0.040
	Present	34(100)	46(88.5)	
Respiratory distress	Absent	3(8.8)	4(7.7)	0.851
	Present	31(91.2)	48(92.3)	
Hypoxemia	Absent	4(11.8)	7(13.5)	0.817
	Present	30(88.2)	45(86.5)	
Pulmonary emphysema	Absent	5(14.7)	1(1.9)	0.022
	Present	29(85.3)	51(98.1)	

Table 2. Sensitivity, specificity, PPV, NPV, PLR and NLR for different clinical variables

Biomarker	Sensitivity	Specificity	PPV	NPV	PLR	NLR
Coughing	100	0	60.5	0	100	0
Crepitation	100	0	60.5	0	100	0
Wheezing	96.1	0	59.5	0	96.1	∞
Breathing sound reduction	88.5	0	57.5	0	88.5	∞
Respiratory distress	92.3	8.8	60.8	75.0	1.0	0.9
Hypoxemia	86.5	13.3	60.0	57.1	1.0	1.0
Pulmonary emphysema	98.1	17.2	63.7	∞	1.1	0.1

When the different clinical and radiological signs cross-tabulated with the RB findings, breathing sound reduction (P=0.040) and pulmonary emphysema (P=0.022) were statistically significant. The detailed cross-tabulation results between RB findings and clinical and radiological signs can be found in Table 1.

Table 2 indicates the data related to sensitivity, specificity, PPV, NPV, PLR, and NLR for each clinical and radiological sign.

Table 3 lists the different types of extracted FB, the most frequently of which was sunflower seeds.

The localization of the FBs is listed in Table 4, indicating that 48.1% were in the right main bronchus.

Table 3. Aspirated foreign bodies

Type of foreign body	N (%)
Sunflower seed	13(25.0)
Rice	3(5.8)
Chick pea	1(1.9)
Almond	3(5.8)
Pin	1(1.9)
Pistachio	4(7.7)
Bone	1(1.9)
Needle	1(1.9)
Corn	1(1.9)
Air bladder	1(1.9)
Unclear	23 (44.2)

Table 4. Foreign body localization

Site	N (%)
Trachea	14(26.9)
Right main bronchus	25(48.1)
Left main bronchus	9(17.3)
Both right and left bronchus	4(7.7)

Discussion

Foreign body aspiration may cause life-threatening complications, necessitating immediate diagnosis and treatment. Although FBA is commonly observed in children under 3 years old, the findings of the current study indicated 2-4 years (73.3%) as the most common age range. On the contrary, Chouhan et al. report that 71% of FBA occurs within the age group between 6 months to 2 years and only 17% from 2 to 3 years (11). The most prevalent etiological factors contributing to FBA identified in children included curiosity and tendency to explore the world by the mouth, the imperfect development of the neuromuscular structures which protect the airways, insufficient laryngeal closure reflex, the inadequate mastication due to the lack of molar teeth, incomplete swallowing reflex, and activity when eating especially crying or yelling (12). Furthermore, FBA is closely associated with sex.

In the present study, the male-to-female ratio was 1.77, consistent with previous studies (11, 13, 14). The higher prevalence of FBA among males may be attributed to their tendency for more vigorous physical activity during preschool, compared to females.

The results showed that the most FBs aspirated in this study were organic, following previous research done in Pennsylvania, Iran, Brazil, and Lebanon (13-15). Sunflower seed was the most common FB (25%), similar to studies done by Safari et al. (15) and Baram et al. (16). Similarly, watermelons, sunflowers, and pumpkins seeds were the most prevalent aspirated FBs in Egypt, Turkey, and Greece, respectively (17). Although bones were more common in Southeast Asia and China (18, 19). These variations may be due to differences in food habits.

The key to a definite diagnosis depends on a detailed and reliable history that detects risk factors, examines signs and symptoms, and supports CXR results. Diagnostic RB should be considered if at least one of the modalities, such as clinical examination or CXR yields a positive finding. However, if both the examination and CXR are negative, it is recommended to repeat both tests 24 hours apart for stable patients (20). In the current study, RB was performed based on these criteria since none of the participants were asymptomatic, and 100% of patients had a positive history of coughing and crepitation. In studies done by Safari et al. (15), Fraga et al. (13), Chouhan et al. (11), and Wadhera et al. (21), the most common symptom was coughing.

In cases of suspected FBA, a CXR is recommended for all patients, although a negative finding does not exclude the diagnosis. In the present study, pulmonary emphysema was detected in 93% of cases using X-ray. However, the X-ray was normal in 7% of patients. These radiological observations resulted in a specificity of 17.2% and sensitivity of 98.1%.

The results demonstrated that none of the clinical symptoms, such as coughing, crepitation, wheezing, breathing sound reduction, respiratory distress, and hypoxemia, demonstrated high sensitivity and specificity when considered individually or in combination. This may be one of the main factors responsible for predicting the outcome of RB. In present study, the coughing and crepitation had very high sensitivity of 100% whereas hypoxemia had highest specificity of 13.3%.

As have been reported in the previous studies, the most common site of the FBs was found to be the right main bronchus (48.1%). This may be due to the position of the bronchus, as the left bronchus has a more acute angle of connection to the trachea, compared to the right bronchus, and the right bronchial diameter is shorter and wider than the left bronchus (13, 14, 22, 23).

There is always a chance of negative RB exposing the patients to the risk of GA and possible perioperative complications of the procedure. The rate of negative RB was 40% in current study. The reported proportion of negative RB in previous studies varied from 1.5% to 57 % (24-26).

In the present study, no mortality was observed, and attempts at a FB extraction using RB were successful in all the patients. This finding is consistent with a previous study on this subject (11). All the patients were postoperatively followed with intravenous antibiotics along with steroid drugs before being discharged.

Conclusion

In conclusion, FBA is an emergency condition that can lead to serious complications. Rigid bronchoscopy is the most rapid and effective method to prevent life-threatening events associated with FBA. This study revealed that FBA most commonly occurred in the age range of 2-4 years, with a male-to-female ratio of 1.77. The location of foreign bodies in most patients was the right main bronchus, and the most common presenting symptoms in clinical findings were coughing and crepitation. None of the clinical symptoms, such as coughing, crepitation, wheezing, breathing sound reduction, respiratory distress, and hypoxemia, have high sensitivity and specificity when considered individually or in combination. Therefore, it is important to educate children and parents about the potential consequences and FBA preventive measures. Moreover, FB extraction may minimalize the risk of long-term complications. However, it is important to acknowledge that the findings of this study are specific to a single hospital and can not be generalized to the broader community. Therefore, there is a need to conduct multi-center research.

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Conflicts of interest

Authors have no conflict of interests.

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References

1. Passàli D, Lauriello M, Bellussi L, Passali G, Passali F, Gregori D. Foreign body inhalation in children: an update. Acta Otorhinolaryngol Ital. 2010;30(1):27-32.
2. Chinski A, Foltran F, Gregori D, Passali D, Bellussi L. Foreign bodies causing asphyxiation in children: the experience of the Buenos Aires paediatric ORL clinic. Int J Med Res. 2010;38(2):655-60.
3. Gregori D, Salerni L, Scarinzi C, Morra B, Berchialla P, Snidero S, et al. Foreign bodies in the upper airways causing complications and requiring hospitalization in children aged 0–14 years: results from the ESFBI study. Eur Arch. 2008;265(8):971-8.
4. Sahin A, Meteroglu F, Eren S, Celik Y. Inhalation of foreign bodies in children: experience of 22 years. J Trauma Acute Care Surg. 2013;74(2):658-63.
5. 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.
6. Mapelli E, Sabhaney V. Stridor and drooling in infants and children. Int Pediatr. 2003;18(213).
7. Eren Ş, 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. Mantor PC, Tuggle DW, Tunell WP. An appropriate negative bronchoscopy rate in suspected foreign body aspiration. Am J Surg. 1989;158(6):622-4.
9. Orji F, Akpeh J. Tracheobronchial foreign body aspiration in children: how reliable are clinical and radiological signs in the diagnosis? Clin Otolaryngol. 2010;35(6):479-85.
10. Righini CA, Morel N, Karkas A, Reyt E, Ferretti K, Pin I, et al. What is the diagnostic value of flexible bronchoscopy in the initial investigation of children with suspected foreign body aspiration? Int J Pediatr Otorhinolaryngol. 2007;71(9):1383-90.
11. Chouhan M, Sharma S. Tracheobronchial foreign bodies: the importance of timely intervention and appropriate collaboration. Indian J Otolaryngol Head Neck Surg. 2019;71(1):972-5.
12. Mu L, Sun D, He P. Radiological diagnosis of aspirated foreign bodies in children: review of 343 cases. J Laryngol Otol. 1990;104(10):778-82.
13. Fraga AdMA, Reis MCd, Zambon MP, Toro IC, Ribeiro JD, Baracat ECE. Foreign body aspiration in children: clinical aspects, radiological aspects and bronchoscopic treatment. J Bras Pneumol. 2008;34:74-82.
14. Rizk H, Rassi S. Foreign body inhalation in the pediatric population: lessons learned from 106 cases. Eur Ann Otorhinolaryngol Head Neck Dis. 2011;128(4):169-74.
15. Safari M, Manesh MRH. Demographic and clinical findings in children undergoing bronchoscopy for foreign body aspiration. Ochsner Journal. 2016;16(2):120-4.
16. Baram A, Sherzad H, Saeed S, Kakamad FH, Hamawandi AM. Tracheobronchial foreign bodies in children: the role of emergency rigid bronchoscopy. Glob Pediatr Health. 2017;24(4):2333794X17743663.
17. Salih AM, Alfaki M, Alam-Elhuda DM. Airway foreign bodies: A critical review for a common pediatric emergency. World J Emerg Med. 2016;7(1):5-12.
18. Patel S, Kazerooni EA. Case 31: foreign body aspiration—chicken vertebra. Radiology. 2001; 218(2):523-5.
19. Lan R. Non-asphyxiating tracheobronchial foreign bodies in adults. Eur Respir J. 1994;7(3):510-4.
20. Wiseman NE. The diagnosis of foreign body aspiration in childhood. Journal of pediatric surgery. 1984;19(5):531-5.
21. Wadhera R, Sehrawat U, Hooda S, Wadhera S. Evaluate the Role of Rigid Bronchoscopy in Tracheo-Bronchial Foreign Bodies. Indian J Otolaryngol Head Neck Surg. 2022;74(Suppl 3):5177-81.
22. 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.
23. Liang J, Hu J, Chang H, Gao Y, Luo H, Wang Z, et al. Tracheobronchial foreign bodies in children–a retrospective study of 2,000 cases in Northwestern China. Ther Clin Risk Manag. 2015;11:1291-5.
24. Oncel M, Sunam GS, Ceran S. Tracheobronchial aspiration of foreign bodies and rigid bronchoscopy in children. Pediatr Int. 2012; 54(4):532-5.
25. Swanson KL, Prakash UB, Midthun DE, Edell ES, Utz JP, McDougall JC, et al. Flexible bronchoscopic management of airway foreign bodies in children. Chest. 2002;121(5):1695-700.
26. Cohen S, Avital A, Godfrey S, Gross M, Kerem E, Springer C. Suspected foreign body inhalation in children: what are the indications for bronchoscopy? J Pediatr. 2009;155(2):276-80.