

A single-center experience of pediatric foreign-body aspiration: A retrospective 4-year case series

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ABSTRACT

Introduction: Foreign body aspirations (FBA) in children are serious life-threatening clinical conditions that require immediate intervention. In this study, it was aimed to retrospectively investigate the demographic features, clinical diagnosis and treatment methods of children admitted to our clinic due to FBA. **Materials and Methods:** The study included 86 children aged <16 years, diagnosed with tracheobronchial foreign body aspiration (FBA) between January 2013 and December 2017. All patients with two-way chest radiography were examined for foreign body aspiration diagnosis. In case of suspicion of diagnosis, low-dose multi-slice chest CT was taken. In cases of FBA diagnosis, rigid bronchoscopy was performed under sevoflurane and propofol anaesthesia supported by controlled ventilation. Evaluation was made of the patient demographic characteristics, type and localization of the foreign body removed with bronchoscopy and operation-related complications. **Results:** The mean age of the patients with FBA diagnosis was 3.17 years and 55.8% ($n = 48$) of the patients were male. The most commonly aspirated foreign body was nuts (peanut and hazelnut) (70%) and the most common finding on the chest radiographs was obstructive emphysema, determined on 51% of the patients. Bronchoscopy revealed that the foreign body was in the right main bronchus and left main bronchus in 41%. **Conclusion:** The main treatment for FBA is prevention. However, in patients applied with bronchoscopy for FBA, controlled ventilation and appropriate general anesthesia should be generally used. Early bronchoscopic intervention with safe anesthesia and controlled ventilation support will improve the success rates in FBA cases.

KEY WORDS: Bronchoscopy, children, foreign-body aspiration, peanut

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INTRODUCTION

Foreign-body aspiration (FBA) in children is serious life-threatening clinical condition that requires immediate intervention. It has been reported to be the cause in 7% of child mortality at the age between 0–3 years and of 40% of accidental deaths in babies <1 year of age.^[1] It is more common in boys (M/F: 1.2–2.6/1) and is a significant cause of infant and child mortality in developing countries.^[2]

Soon after aspiration or within a few hours, children with FBA are brought to the emergency department with

a feeling of suffocation, stubborn cough, and wheezing due to partial or total occlusion of the respiratory tract. Children with FBA will have to undergo bronchoscopy after a detailed physical examination, imaging methods, and high clinical suspicion. The size of the foreign body in particular, occlusion area, organic or inorganic properties, and shape and duration after ingestion are of great importance.

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It is our main goal to raise awareness of FBA, which is an important cause of mortality in children under the age of 3 years in Turkey, and to discuss the diagnostic and therapeutic intervention methods. The increasing use of bronchoscopic intervention and the sharing of experience in recent years will make an important contribution to this issue. The aim of this study is to retrospectively investigate the demographic features, clinical diagnosis, and treatment methods of children admitted to our clinic due to FBA.

MATERIALS AND METHODS

The study included 86 children aged <16 years, diagnosed with tracheobronchial foreign-body aspiration (FBA) between January 2013 and December 2016. Retrospective analysis was made of the patient age and gender, foreign-body characteristics and location, treatment modalities, and clinical outcomes. Postero-anterior and lateral chest radiographs were taken of all the cases [Figure 1a]. In cases where direct radiographic findings were normal, but there was a high level of suspicion, low-dose thoracic computed tomography (CT) was used [Figure 1b]. When FBA was diagnosed with a result of the evaluations, bronchoscopy was performed under general anesthesia [Figure 2a and b]. Induction of anesthesia was applied with 2 mg/kg propofol or 3 mg/kg pentothal injection and 1 mcg/kg remifentanyl was administered as narcotic analgesia.

The anesthesia was maintained with 2%–4% sevoflurane in a 50%O₂-50% air mixture and the operation continued with controlled ventilation. Depending on the size and other properties of the foreign body, it was removed from the respiratory tract using different sizes of alligator forceps, grasping forceps, basket forceps, biopsy forceps, or Fogarty balloon catheter (either single or combined). Standard monitorization was applied with electrocardiography, systolic and diastolic arterial blood pressures, heart rate, and peripheral oxygen saturation. Parenteral ampicillin/sulbactam (four doses per day 100–200 mg/kg) was given as an empirical antibiotic in all the cases undergoing bronchoscopy. Postoperative evaluation was made with chest X-ray and physical examination. All the children were monitored in hospital for at least 24 h after the procedure. Evaluation was made of the patient demographic characteristics, type, and localization

of the foreign body removed with bronchoscopy and operation-related complications.

RESULTS

The 86 patients comprised 48 (55.8%) females and 38 (44.2%) males with a median age of 3 years of age (range: 1 month–16 years). Age groups of the patients were 82.0% (*n* = 71) 0–4 years of age, 11.62% (*n* = 10) 5–10 years of age, and 5.81% (*n* = 5) ≥10 years of age. Place of residence was rural area in 73.3% (*n* = 63) and city center in 26.7% (*n* = 23). In the evaluation of the maternal education level, 59.3% (*n* = 51) had attended primary school only, 31.4% (*n* = 27) high school, 7% (*n* = 6) had higher level of education, and 2.3% (*n* = 2) were university graduates. The total number of children in the families was determined as 1–3 in 39.5% (*n* = 34), 4–6 in 55.8% (*n* = 48) and ≥7 in 4.7% (*n* = 4). Patients were divided into two age groups as <36 (*n* = 35) and ≥36 (*n* = 51) months; There were no significant differences in terms of laboratory parameters, vital signs, genders among patients, total number of children in the home, time of admission to hospital, and education level of mothers (*P* > 0.05) [Table 1].

On the direct thoracic radiographs taken on admission, obstructive emphysema was determined in approximately half the cases. In one case, no radiological abnormality was determined. Bronchoscopy revealed foreign-body localization in the right main bronchus in 53.5%, in the left in 41.9%, and in the trachea in 4.6%. The foreign bodies removed were recorded in 27 cases (31.4%) as peanuts, in 14 cases (16.3%) as hazelnuts, in 13 cases (15.1%) as sunflower seeds, in 10 cases (11.6%) as plastic objects, in 9 cases (10.5%) as corn kernels, and in 4 cases (4.6%) metal objects. In nine cases, the foreign body could not be clearly identified as it had disintegrated into small parts or was too small.

When the children were compared according to the intervention methods, no statistically significant difference was found between the groups (*P* > 0.05) [Table 2].

DISCUSSION

Foreign-body aspirations (FBA) are a leading cause of death in children. Immediate intervention is necessary as delays

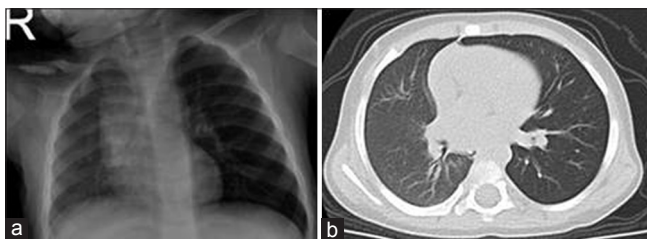


Figure 1: (a) Direct thoracic radiograph of a patient with a bone fragment in the left main bronchus, (b) thorax computed tomography image

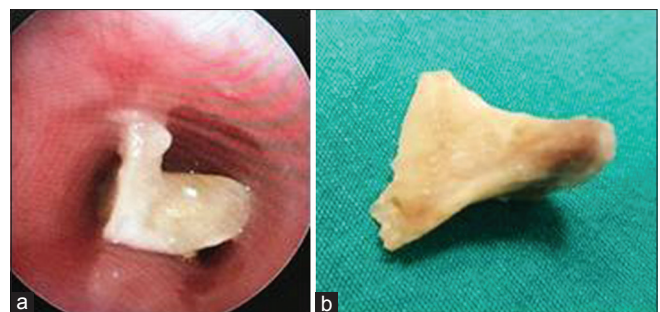


Figure 2: (a and b) The bone fragment successfully removed with bronchoscopy

in diagnosis and treatment can lead to serious pulmonary damage, or may even be fatal. Although FBA can be seen at any age, it is more common in early childhood up to the age of 3 years, at the time when children tend to place all objects in the mouth, or accidental ingestion may occur when

playing.^[3] In this period, when children tend to place objects in the mouth, the risk of aspiration is increased as the molar teeth are not fully formed, and they have generally had not sufficient training in eating. Actions such as laughing, crying, or running while eating also lead to a higher risk of aspiration.^[4] It has been reported that FBA is the cause of 7% of child mortality between the ages of 0–3 years.^[2,5]

Table 1: Demographic characteristics of the patients and laboratory parameters

	FBA groups (<36 or ≥36 months)		P
	<36 months	≥36 months	
	(n=35) n (%)	(n=51) n (%)	
Gender			
Female	15 (42.9)	23 (45.1)	0.999
Male	20 (57.1)	28 (54.9)	
	Median	Median	
	(Min./Max.)	(Min./Max.)	
Total number of children in the family			
1-3	16 (45.7)	18 (35.3)	0.600
4-6	18 (51.4)	30 (58.8)	
≥ 7	1 (2.9)	3 (5.9)	
Time from incident to presentation at hospital (days)			
0-1	24 (68.6)	30 (58.8)	0.225
2-7	4 (11.4)	9 (17.6)	
7-14	4 (11.4)	6 (11.8)	
≥15	3 (8.6)	6 (11.8)	
Education level of the mothers			
Primary school	20	31	0.398
High school	10	17	
Further education	3	3	
University or higher	2	0	

Pearson Chi-Square Test (Exact), Fisher Freeman Halton Test (Monte Carlo), Mann Whitney U test (Monte Carlo), Min.: Minimum, Max.: Maximum

The median age of the patients in the study was 3 years, which is consistent with literature. In previous studies, the incidence of FBA has been reported to be higher in boys than in girls with the male/female ratio of 3:2–2:1. This could be explained by higher activity levels in boys than girls.^[3] In this study, 55.8% of the patients were male, which was in accordance with previous findings in literature.

Foreign-body aspirations in Turkey and other developing countries remain an important health problem. In a worldwide review by Foltran *et al.*,^[6] the highest number of cases of FBA were seen in Turkey. The properties of the aspirated object may vary depending on social and cultural factors and the eating habits of the child. In many cases, the aspirated object migrates into the tracheobronchial space. Some of these objects are aspirated food such as nuts, seeds, vegetables, and fruit. The most commonly aspirated objects in the current study were peanuts, hazelnuts, and sunflower seeds, which are frequently found in homes in Turkey as snacks.

Following physical examination, the most commonly used imaging technique in cases of FBA is direct thoracic posteroanterior and lateral radiographs.^[7] The most common radiological finding in FBA is emphysema

Table 2: Radiographic and bronchoscopic findings

	Bronchoscopy methods (Rigid, Flexible or combined with Fogarty Balloon Catheter)			P
	Rigid Bronchoscopy	Flexible Bronchoscopy	Combined with Fogarty	
	(n=48) (%)	(n=31) (%)	(n=7) (%)	
	n (%)	n (%)	n (%)	
Gender				
Female	20 (41.7)	16 (51.6)	2 (28.6)	0.507
Male	28 (58.3)	15 (48.4)	5 (71.4)	
Radiographic findings				
Obstructive emphysema	28 (58.3)	17 (54.8)	2 (28.6)	0.144
Normal	12 (25)	5 (16.1)	1 (14.2)	
Foreign body opacity	6 (12.5)	4 (12.9)	2 (28.6)	
Pneumonic infiltration	1 (2.1)	3 (9.7)	0	
Atelectasis	1 (2.1)	2 (6.5)	2 (28.6)	
Occlusion				
Right main bronchus	29 (60.4)	13 (42)	4 (57.1)	0.391
Left main bronchus	16 (33.3)	17 (54.8)	3 (42.9)	
Trachea	3 (6.3)	1 (3.2)	0	
Aspirated material				
Peanut	18 (37.5)	9 (29)	3 (42.9)	0.483
Hazelnut	10 (20.8)	4 (12.9)	2 (28.6)	
Sunflower seed	8 (16.7)	5 (16.1)	0	
Plastic object	7 (14.5)	3 (9.7)	1 (14.3)	
Corn kernel	3 (6.3)	6 (19.3)	1 (14.3)	
Metal object	2 (4.2)	2 (6.5)	0	
Other, unspecified	0	2 (6.5)	0	

Fisher Freeman Halton Test (Monte Carlo)

or atelectasis. Emphysema is caused by air trapped in the pulmonary lobe in expiration.^[8,9] The most common finding on the chest X-rays in this study was obstructive emphysema, which was observed distal to the obstruction. In a study by Oğuz *et al.*,^[4] FBA patients were separated into two groups according to presentation within the first 24 h or later. While the pulmonary radiographs of the early presenting group were found to be generally normal, radiological findings such as pneumonia and atelectasis were observed in the late-presenting group.

Chest CT should only be performed in selected cases due to the exposure to high-dose radiation. It should not be applied in delayed cases or when there are definite bronchoscopy indications. The sensitivity of thoracic CT in FBA is close to 100% and specificity is 66%–100%.^[10] In recent years, developments in the software for three-dimensional CT and virtual bronchoscopic images have provided sensitivity, specificity, and accuracy of virtual bronchoscopy at 88%, 91%, and 90%, respectively. However, there are also reports with conflicting results showing that virtual bronchoscopy practice does not provide any additional information on FBA. The main treatment modality in FBA is bronchoscopy. Every child with a history of FBA must be applied with bronchoscopy with a specific algorithm. Bronchoscopy can be applied flexibly or rigidly. Rigid bronchoscopy is successfully used in our clinic.

Foreign bodies aspirated into the tracheobronchial tree are usually localized in the right bronchial system due to the anatomical branching of the tracheobronchial system. The right main bronchus is shorter, wider, and closer to the trachea than the left. In children, the main bronchial branching angles and sizes are similar to each other, unlike in adults. Therefore, in children, the FB is usually seen in close proximity to both main bronchi. In the current study, the bronchoscopy results showed that the foreign body was seen more often in the right main bronchus, but localization in both bronchial branches were recorded. In children with FBA, choking or the appearance of bruising is usually recognized by the family. However, it has been reported in literature that although approximately 90% of children have a similar history of early onset, approximately 1% of patients are brought to hospital 1 month or later after aspiration.^[11,12]

The awareness of parents, especially mothers, in respect of this issue seems to be closely related to the level of education. In the current study, approximately half of the mothers presented early at the hospital, despite a low level of education. This was thought to be related to the increased awareness of families and easier access to health care.

Atelectasis, pneumonia, pulmonary abscesses, and bronchiectasis may develop when diagnosis and treatment are delayed, and may be confused with asthma or allergic bronchiolitis. In developed countries, plastic toy parts

and metal pieces are the most frequently aspirated objects.^[13,14] In underdeveloped countries, the most commonly aspirated foreign objects in childhood are food such as peanuts, hazelnuts, chickpeas and corn kernels. The most important features of these food items are that they expand in volume by absorption of bronchial secretions and disintegrate easily over time. Because of these aforementioned features, FBA may be asymptomatic at onset, but very serious symptoms can develop in a short period. However, as the foreign body disintegrates easily, it may well disintegrate during the endoscopic intervention and hence may advance easily to more distal airways.^[15,16] In the current study, the aspirated foreign body was seen to be pieces of nuts in 63 cases (73%). The most commonly aspirated organic foreign body was peanuts, which is consistent with sociocultural factors and nutrition habits of the geographical region.

It has been emphasized in the literature that bronchoscopy must be chosen in all cases of FBA to prevent morbidity. Stated that some negative bronchoscopies are inevitable in the prevention of morbidity resulting from missed FBA.^[17]

The complication rate of bronchoscopy is very low when it is performed by an experienced team along with the appropriate equipment. The complication rate is known to increase after 24 h in misdiagnosed cases. Complications that may be encountered during procedure include hypoxia, hypercarbia, bronchospasm, vocal cord injury, laryngeal edema, post-operative infection, hemorrhage, pneumothorax, pneumomediastinum, tracheal and bronchial rupture, bradycardia, and cardiac arrest. Using the appropriate diameter of bronchoscope and keeping the bronchoscopy time short will reduce the risk of edema, and bronchospasm. The use of steroids before and after the procedure is also beneficial. In literature, residual foreign bodies, especially degraded organic matter, have been reported at the rate of 10%. If there is suspicion of residual matter, the bronchoscopy should be repeated.^[3,17] In the current study, no repeat bronchoscopy was required in any patient and no complications occurred during the bronchoscopy procedures.

A rigid bronchoscope provides good ventilation while removing the foreign body. Rigid bronchoscopy is a diagnostic and therapeutic procedure with a success rate close to 100% when applied by experienced hands. In pediatric cases, complications have been reported at a low rate of 2%–8%.^[9,10,18,19] In a study by Annigeri and Patil,^[20] it was recommended that in all children undergoing rigid bronchoscopy for an FBA diagnosis, controlled ventilation should be maintained with propofol and sevoflurane during the bronchoscopy to lower the risk of pulmonary complications. In accordance with this recommendation, controlled ventilation was performed with propofol and sevoflurane in this study. This significantly facilitated the procedure, and successful results were obtained despite challenging bronchoscopic maneuvers.

There were some limitations to this study, primarily that it was retrospective in nature and the number of patients was low. In addition, the absence of a defined algorithm for the steps to be followed in pediatric emergency FBA cases itself can be considered a significant limitation. Nevertheless, an important strength of this study is that controlled ventilation was successfully achieved in all patients with the administration of propofol and sevoflurane.

Childhood aspiration of foreign bodies is preventable, and there is a need for greater focus on prevention strategies through community education and raising awareness. It has been reported that FBA incidence can be reduced by 35% with public health education programs.^[21]

CONCLUSIONS

As the main treatment of FBA is prevention, raising community awareness, especially through education programs run by hospitals or family doctors are as important as the diagnosis and treatment of FBA. In pediatric patients undergoing bronchoscopy for diagnosis of FBA, controlled ventilation with the appropriate general anesthesia should be routine. Risks can be reduced at home by keeping the children under the age of 3 years away from nuts and other small food items. Community and family awareness can be increased by more frequent use of visual and written media, and the commercial sale of nuts should be regulated in appropriate packaging with a “+3 years of age” legal warning.

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Conflicts of interest

There are no conflicts of interest.

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