

Tracheobronchial Foreign Body Aspirations for Children

Çocuklarda Trakeobronşiyal Yabancı Cisim Aspirasyonları

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ABSTRACT

Aim: Tracheobronchial foreign body aspiration (FBA) is a leading cause of accidental injury and sudden death in childhood. This study aimed to categorize pediatric patients under the age of 16 years with tracheobronchial FBA into distinct age groups, compare gender distribution, assess clinical and radiological findings, characterize the types of aspirated foreign body (FB), and evaluate preventive measures to reduce the incidence of FBA.

Material and Methods: This retrospective study included patients under the age of 16 years who were evaluated for suspected tracheobronchial FBA between 2010 and 2019. The patients were categorized into four age groups: ≤ 3 years, 4-7 years, 8-10 years, and >10 years.

Results: Among the 132 patients included, 80 (60.6%) were male, and 52 (39.4%) were female. The FBA was found to be significantly ($p=0.003$) most prevalent among males aged ≤ 3 years (72.7%, $n=32$) and among females aged >10 years (59.2%, $n=29$). The type of aspirated FB significantly varied by age group, with dried nuts being the most aspirated in children ≤ 3 years (50.0%, $n=22$), stationery items in the 8-10 years (47.1%, $n=8$), and headscarf needles in the >10 -year (36.7%, $n=18$) groups ($p<0.001$).

Conclusion: The type of aspirated FBs varies according to age and cultural factors. The severity of FBA-related complications depends on the size, shape, and location of the aspirated object, as well as the patient's age, duration of aspiration, and degree of airway obstruction. Enhancing public awareness, facilitating early diagnosis, and ensuring prompt treatment are crucial for minimizing FBA-related complications and mortality.

Keywords: Foreign body; tracheobronchial aspiration; bronchoscopy; child.

ÖZ

Amaç: Trakeobronşiyal yabancı cisim aspirasyonu (YCA), çocukluk çağında kazara yaralanmaların ve ani ölümlerin önde gelen nedenidir. Bu çalışmada, trakeobronşiyal YCA olan 16 yaş altı çocukların farklı yaş gruplarına göre kategorize edilmesi, cinsiyet dağılımının, klinik ve radyolojik bulguların, aspire edilen yabancı cisim (YC) tiplerinin karşılaştırılarak YCA insidansının azaltılması için koruyucu önlemlerin değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Bu geriye dönük çalışmaya 2010 ve 2019 yılları arasında trakeobronşiyal YCA şüphesi ile değerlendirilen 16 yaşından küçük hastalar dahil edilmiştir. Hastalar dört yaş grubuna ayrılmıştır: ≤ 3 yaş, 4-7 yaş, 8-10 yaş ve >10 yaş.

Bulgular: Çalışmaya dahil edilen 132 hastadan 80'i (%60,6) erkek ve 52'si (%39,4) kadındı. YCA'nın, ≤ 3 yaş erkeklerde (%72,7; $n=32$) ve >10 yaş kadınlarda (%59,2; $n=29$) anlamlı olarak en yaygın olduğu bulundu ($p=0,003$). Aspire edilen YB tipleri yaş grubuna göre anlamlı bir şekilde değişiyordu; kuru yemişler ≤ 3 yaş çocuklarda (%50,0; $n=22$), kırtasiye malzemeleri 8-10 yaş grubunda (%47,1; $n=8$) ve başörtüsü iğneleri ise >10 yaş grubunda (%36,7; $n=18$) en çok aspire edildi ($p<0,001$).

Sonuç: Aspire edilen YC türleri yaş grubuna ve kültürel faktörlere göre değişmektedir. YCA ile ilişkili komplikasyonların şiddeti, aspire edilen cismin büyüklüğüne, şekline ve lokalizasyonuna, ayrıca hastanın yaşına, aspirasyon süresine ve hava yolu tıkanıklığının derecesine bağlıdır. Kamuoyunun farkındalığını artırmak, erken tanıyı kolaylaştırmak ve hızlı tedaviyi sağlamak, YCA ile ilişkili komplikasyonları ve mortaliteyi en aza indirmek için çok önemlidir.

Anahtar kelimeler: Yabancı cisim; trakeobronşiyal aspirasyon; bronkoskopi; çocuk.

INTRODUCTION

Tracheobronchial foreign body aspiration (FBA) is most commonly observed in pediatric populations and constitutes a medical emergency necessitating prompt diagnosis and intervention. The severity of FBA-related complications depends on the size, shape, and location of the aspirated object, as well as the patient's age, duration of aspiration, and degree of airway obstruction. In severe cases, FBA can result in life-threatening complications and even death (1-3). In the United States, 160 children under the age of 14 died due to FBA in 2000, and it accounts for 7% of deaths in children under the age of 3 (2-5).

The type of foreign body (FB) aspirated varies according to age, geographic region, dietary habits, seasonal factors, and socioeconomic conditions. Studies have shown that in children under 3 years of age, the most frequently aspirated FBs are nuts and seeds, such as hazelnuts, peanuts, and roasted chickpeas (1,6,7). In Muslim societies like Türkiye, headscarf needle aspiration is a significant concern in girls aged 10 years and older (8). The primary treatment for FBA in children is rigid bronchoscopy, while fiberoptic bronchoscopy (FOB) may be used in selected cases (9). Delayed diagnosis and treatment can lead to recurrent lung infections, irreversible atelectasis, and bronchiectasis, potentially necessitating lung resection (1,5). Moreover, hypoxic-ischemic encephalopathy has been reported due to prolonged airway obstruction (10). Therefore, early diagnosis and intervention are critical to prevent serious complications and fatalities (1,2,10).

Aspirated FBs differ by age group. Children under 3 years commonly aspirate nuts and food particles, preschool-aged children often aspirate toy parts, school-aged children frequently aspirate stationery items such as pen caps and springs, and adolescent girls (≥ 10 years old) are at high risk for headscarf needle aspiration (1,8,11).

This study aimed to categorize pediatric patients under 16 years of age with FBA into distinct age groups, compare gender distribution, characterize the FB types, assess clinical presentations and radiological findings, and identify preventive strategies to reduce FBA-related morbidity and mortality.

MATERIAL AND METHODS

This retrospective study analyzed 291 patients evaluated for suspected tracheobronchial FBA between 2010 and 2019 in our clinic. Among these, 151 patients (51.9%) were below 16 years. Nineteen (12.6%) patients in whom FBs could not be detected during clinical and radiological evaluations were excluded from the study.

A total of 132 patients (87.4%) under the age of 16 with confirmed FBA were included in the study. The patients were categorized into four age groups: ≤ 3 years, 4-7 years, 8-10 years, and >10 years.

The differences between the groups were analyzed in terms of gender, presenting symptoms, physical examination findings, radiological findings, time from aspiration to hospital admission, FB type, localization, treatment approach, and procedural complications. The time to hospital admission was defined as the interval between the aspiration event or the onset of symptoms and the patient's presentation to the hospital.

For all patients, posteroanterior chest radiographs were obtained during inspiration. In cases where the initial

radiographic findings were normal, additional expiratory or lateral radiographic images were taken to enhance diagnostic accuracy.

Bronchoscopy Treatment Protocol

The treatment approach was determined based on patient history, physical examination, and radiological findings. In cases where radiological evaluation did not confirm the presence of an FB, but anamnesis and/or physical examination suggested aspiration, the families were informed about the potential risks, and further evaluation was conducted. For patients with severe dyspnea due to tracheobronchial FB obstruction, rigid bronchoscopy was performed under general anesthesia (GA) in an emergency setting. In other cases, prior to bronchoscopy, the following laboratory tests were conducted: complete blood count, comprehensive biochemical analysis, coagulation tests, and blood group determination. Bronchoscopy was performed after a minimum 5-hour fasting period. FOB was used as an adjunctive treatment in cases where the FB was located in the distal airways or the upper lobe bronchus and could not be accessed using rigid bronchoscopy. Surgical intervention was performed for cases in which the FB could not be removed despite all endoscopic attempts. A comprehensive evaluation of the central airway, including both bronchial systems, was performed to rule out bilateral FBA. Following rigid bronchoscopy under GA, patients were monitored in the intensive care unit for 2 hours. For cases in which bronchoscopy lasted longer than 20 minutes, oxygen therapy via mask, nebulized steam therapy, and steroid treatment were administered. A post-procedural chest X-ray was routinely performed following bronchoscopy.

Ethical approval for this study was obtained from the Keçiören Training and Research Hospital Clinical Research Ethics Committee (09.03.2021, 2249).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics for the variables in the study were expressed as numbers and percentages. Chi-square or Fisher's exact test was calculated to determine the relationships between categorical variables. A p-value of <0.05 was considered statistically significant.

RESULTS

Among the 132 patients included in the study, 80 (60.6%) were male and 52 (39.4%) were female. The mean age of the patients was 8.4 ± 5.5 (range, 1-16) years. When analyzed by age groups, males predominantly belonged in the ≤ 3 -year-old group, whereas females were predominantly in the >10 -year-old group, with a statistically significant difference ($p=0.003$).

The largest proportion of patients (37.1%, $n=49$) belonged to the >10 -year-old group, followed by the ≤ 3 -year-old group (33.3%, $n=44$).

The majority (64.4%, 85) of the patients across all age groups were admitted within the first 24 hours following aspiration. However, in the ≤ 3 -year-old group, seven patients had no history of aspiration, and they were referred to our clinic by the pediatrics department due to chronic cough and suspected FBA. All remaining patients had a confirmed history of aspiration.

The most frequently reported symptoms in patients were cough (70.5%, n=93) and shortness of breath (40.2%, n=53). However, no statistically significant difference was observed between the age groups ($p=0.141$ and $p=0.723$, respectively). Additional symptoms included cyanosis and vomiting, which were more common in the ≤ 3 -year-old group, while chronic infection and shortness of breath were more frequently observed in the >10 -year-old group. No statistically significant relationship was observed. However, wheezing was found to be significantly more frequent in the ≤ 3 years age group ($p=0.032$). Physical examination findings were generally unremarkable; however, diminished breath sounds were the second most common finding in the ≤ 3 -year-old group ($p=0.069$). Chest X-rays were normal in 59 (44.7%) patients, whereas FBs were directly visualized in 28 (21.2%) patients. When evaluated according to age groups, FBs were detected most frequently in the >10 age group. A statistically significant

relationship was observed between chest X-ray findings and age groups ($p<0.001$, Table 1, Figure 1).

Bronchoscopy was performed as an emergency procedure in 29 (22.0%) patients due to severe respiratory distress, while in the remaining cases, the procedure was conducted under elective conditions. Under GA, rigid bronchoscopy was performed in 104 (78.8%) cases, while FOB with local anesthesia and sedation was performed in 28 (21.2%) cases.

In terms of FB localization, 88 (66.7%) cases had FBs in the right bronchial system, 34 (25.8%) cases had FBs in the left bronchial system, 10 (7.5%) cases in the trachea, and 56 (42.4%) cases in the lower lobes (Table 1).

The FBs were most frequently located in the main bronchus in the ≤ 3 -year-old group, while they were most commonly found in the lower lobes in the >10 -year-old group. No statistical significance was found in FB localization between age groups ($p=0.138$).

Table 1. Patient characteristics according to age groups

	≤ 3 years (n=44)	4-7 years (n=22)	8-10 years (n=17)	>10 years (n=49)	P
Gender, n (%)					
Female	12 (27.3)	8 (36.4)	3 (17.6)	29 (59.2)	0.003
Male	32 (72.7)	14 (63.6)	14 (82.4)	20 (40.8)	
Admission Time, n (%)					
0-24 h	25 (56.8)	14 (63.6)	15 (88.2)	31 (63.3)	0.506
<7 day	11 (25.0)	4 (18.2)	1 (5.9)	9 (18.4)	
>7 day	8 (18.2)	4 (18.2)	1 (5.9)	9 (18.4)	
Symptoms, n (%)					
Cough, n (%)	29 (65.9)	12 (54.5)	14 (82.4)	38 (77.6)	0.141
Shortness of breath, n (%)	16 (36.4)	11 (50.0)	6 (35.3)	20 (40.8)	0.723
Wheezing, n (%)	5 (11.4)	0 (0.0)	1 (5.9)	0 (0.0)	0.032
Cyanosis, n (%)	7 (15.9)	3 (13.6)	0 (0.0)	3 (6.1)	0.184
Chronic infection, n (%)	3 (6.8)	2 (9.1)	0 (0.0)	5 (10.2)	0.684
Vomiting, n (%)	5 (11.4)	1 (4.5)	1 (5.9)	2 (4.1)	0.594
Physical Examination, n (%)					
Normal	18 (40.9)	13 (59.1)	12 (70.6)	34 (69.4)	0.069
Ral/ronkus	11 (25.0)	3 (13.6)	2 (11.8)	8 (16.3)	
Diminished breath sounds	13 (29.5)	3 (13.6)	2 (11.8)	3 (6.1)	
Stridor	2 (4.5)	3 (13.6)	1 (5.9)	4 (8.2)	
Chest X-ray, n (%)					
Normal	22 (50.0)	12 (54.5)	4 (23.5)	21 (42.9)	<0.001
Foreign body	0 (0.0)	3 (13.6)	7 (41.2)	18 (36.7)	
Obstructive emphysema of the lung	9 (20.5)	2 (9.1)	1 (5.9)	0 (0.0)	
Atelectasis	9 (20.5)	2 (9.1)	3 (17.6)	1 (2.0)	
Consolidation	4 (9.1)	3 (13.6)	2 (11.8)	9 (18.4)	
Side, n (%)					
Right	29 (65.9)	12 (54.5)	13 (76.5)	34 (69.4)	0.391
Left	14 (31.8)	7 (31.8)	3 (17.6)	10 (20.4)	
Trachea	1 (2.3)	3 (13.6)	1 (5.9)	5 (10.2)	
Location, n (%)					
Trachea	1 (2.3)	3 (13.6)	1 (5.9)	5 (10.2)	0.138
Main bronchus	20 (45.5)	6 (27.3)	5 (29.4)	10 (20.4)	
Upper bronchus	2 (4.5)	0 (0.0)	0 (0.0)	2 (4.1)	
Intermediate bronchus	4 (9.1)	1 (4.5)	4 (23.5)	12 (24.5)	
Lower bronchus	17 (38.6)	12 (54.5)	7 (41.2)	20 (40.8)	
Foreign Body, n (%)					
Dried nuts	22 (50.0)	7 (31.8)	5 (29.4)	5 (10.2)	<0.001
Food scraps	7 (15.9)	5 (22.7)	1 (5.9)	10 (20.4)	
Headscarf needle	0 (0.0)	2 (9.1)	2 (11.8)	18 (36.7)	
Toys	14 (31.8)	3 (13.6)	1 (5.9)	0 (0.0)	
Stationery items	1 (2.3)	5 (22.7)	8 (47.1)	16 (32.7)	

The type of aspirated FBs significantly varied by age group ($p < 0.001$). The most frequently aspirated objects were dried nuts for ≤ 3 years, stationery items were the most commonly aspirated objects in 8-10 years, and the most frequently aspirated object was the headscarf needle for >10 years (Table 1, Figure 2).

In two cases where headscarf needles were lodged in the distal bronchial system and could not be removed via rigid bronchoscopy, bronchotomy with posterolateral thoracotomy was performed for FB extraction.

Post-bronchoscopy complications included bronchospasm in 8 (6.1%) cases, laryngeal edema in 14 (10.6%) cases, and desaturation in 21 (15.9%) cases. These patients were treated with steroids, anti-inflammatory agents, bronchodilators, and oxygen therapy. Following the procedure, 107 (81.1%) patients were discharged on the same day, 23 (17.4%) patients were discharged 1 day post-procedure, and 2 (1.5%) patients who underwent thoracotomy were discharged on postoperative day 5. No mortality was recorded during the study period.

DISCUSSION

The FBA can be a life-threatening condition in children, necessitating immediate diagnosis and intervention. The incidence of FBA is significantly higher (53-92.1%) in children <3 years of age (1,5,7,10,12). Additionally, in Muslim countries, a distinct pattern is observed among adolescent females, where the aspiration of headscarf needles is particularly common, with a median age of 14 years (8). The high incidence of FBA in young children is attributed to several factors, including their natural tendency to explore objects with their mouths, the absence of molar teeth, which makes chewing difficult and results in food being held in the mouth, and the increased risk of aspiration during crying or laughing. Other contributing factors include playing with age-inappropriate toys, consumption of unsuitable foods, and inadequate parental supervision due to unawareness or lack of education (1,13-16). Interestingly, our study differs from previous reports as we identified a significantly higher incidence of FBA in children >10 years of age compared to those <3 years. We hypothesize that this discrepancy may be due to the referral patterns in our healthcare system. As our institution is a thoracic surgery clinic, younger children are more frequently referred to the pediatric surgery clinic, potentially leading to an underrepresentation of this age group in our dataset.

The male predominance in FBA is well-documented in the literature, with rates ranging from 63-65% for males and 34-36% for females (1,3,5). In our study, the distribution was 60.6% male and 39.4% female, aligning with these findings. While the male-to-female ratio was higher in younger age groups, we observed a reverse trend in children >10 years. This reversal is likely due to the high prevalence of headscarf needle aspiration among adolescent females, a practice by Muslim women in Türkiye, who use these needles to secure their headscarves.

The timing of admission following aspiration varies, with most cases presenting within the first 24 hours (10-50%), while 22-57.6% seek medical attention within the first week, and 3.9-20% present after 1 week (9,17-19). Our study is consistent with the literature, as the majority of all patients were admitted within the first 24 hours.

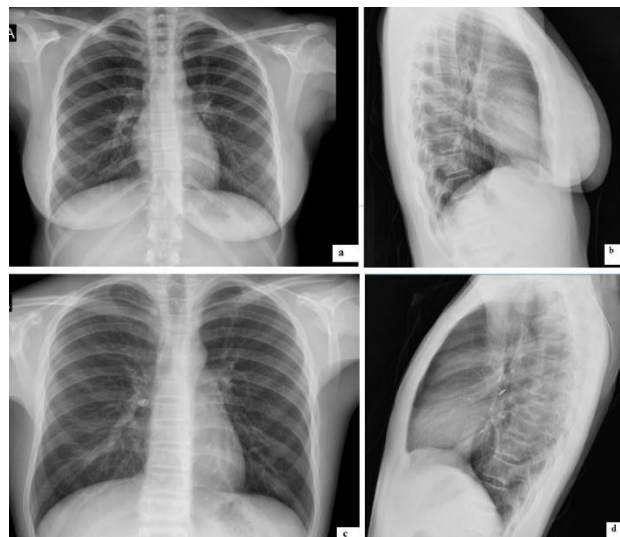


Figure 1. a) A 12-year-old female patient, chest X-ray plain shows a headscarf needle in the right lower lobe bronchus, **b)** the lateral chest X-ray; **c)** A 9-year-old male patient, chest X-ray plain shows a thumbtack right intermediate bronchus, **d)** the lateral chest X-ray



Figure 2. Some of the tracheobronchial foreign bodies

The clinical presentation of FBA depends on several factors, including the elapsed time since aspiration, the size and location of the FB, and the degree of airway obstruction. The classic triad of FBA symptoms includes a sudden-onset cough, shortness of breath, and wheezing with decreased unilateral breath sounds. These findings are crucial for early diagnosis (7,15,20). In our study, cough was the most frequently reported symptom across all age groups.

Although physical examination findings are often unremarkable, decreased breath sounds are commonly observed in young children due to airway obstruction (1,5). Our results are consistent with those of previous reports, as decreased breath sounds were the most common physical examination finding in our study group.

In all suspected cases, radiological imaging is essential to determine the localization of the FB. The primary imaging modalities include anteroposterior and lateral chest X-rays

and thoracic computed tomography. In cases where the FB is radiopaque, it can be easily visualized on imaging studies. However, radiolucent FBs may not be directly detectable, and instead, secondary changes such as atelectasis, emphysema, or pneumonia may indicate aspiration (5,21). It is crucial to perform lateral chest X-rays, as radiopaque objects positioned behind mediastinal structures may not be visible on anteroposterior imaging. However, it is important to note that 24-30% of FBs may not cause significant radiological changes, leading to false-negative results (21-23). The sensitivity and specificity of radiological evaluations have been reported as 62-77% and 57-74%, respectively (24,25). Therefore, normal chest X-rays do not rule out FBA, and in cases of persistent clinical suspicion, bronchoscopy should be performed (21,22). In our study, radiological findings were normal in most cases, aligning with previous literature. However, the radiopaque headscarf needle could be detected in radiological imaging.

A detailed patient history is a cornerstone in diagnosing FBA. However, young children are highly active, and aspiration events often occur outside of parental supervision, leading to unreported or unnoticed incidents. Consequently, clinical findings are more critical than radiology or history-taking in young children, and bronchoscopy should be performed in suspected cases, even in the absence of a definitive history (26,27).

Bronchoscopy remains the gold standard for both diagnosis and treatment of FBA (27). Rigid bronchoscopy is preferred in pediatric patients due to its wide lumen, ability to accommodate large forceps, and simultaneous ventilation capability (2,28). However, some studies advocate for FOB, as it does not require GA and allows for better access to the upper lobe and small-diameter bronchi (29,30). In our study, rigid bronchoscopy under GA was performed in 104 (78.8%) cases, while FOB was utilized in 28 (21.2%) cases where the FB was located in the distal airways or upper lobes. Negative bronchoscopy rate varies 10-37.7% in the literature (11,18,27,29). Considering the potential complications of undiagnosed FBA, such as lung infections, abscesses, and bronchiectasis, this rate is considered acceptable. In our study, the negative bronchoscopy rate was 12.6%, consistent with prior research.

Surgical removal of FBs via thoracotomy may be necessary in cases where the FB is peripherally located and cannot be extracted through endoscopy. Kaptanoğlu et al. (8,31) reported the need for thoracotomy and bronchotomy in 1 out of 63 cases and 2 out of 121 cases involving headscarf needle aspiration. Similarly, in a large cohort of 1,035 cases, Hasdıraz et al. (32) performed thoracotomy in six cases, including lobectomy in four cases due to distal FB localization. In our study, two out of 18 patients with aspirated headscarf needles required thoracotomy and bronchotomy, and the FBs were successfully removed.

FBs are most commonly detected in the right bronchus, as it is shorter, wider, and more vertical, resembling the trachea (33). However, in children, the left main bronchus is anatomically closer to the right main bronchus, which can result in a more balanced distribution of FBs (2). In previous studies, FB localization rates were reported as 34% in the trachea, 34-51% in the right bronchial system, and 15-53% in the left bronchial system (5,29,34,35). Our findings were consistent, with the majority of FBs detected in the right bronchial system.

The type of FB aspirated is influenced by cultural and dietary habits. Young children (<3 years) most commonly aspirate nuts and seeds, whereas school-aged (8-10 years) children frequently aspirate stationery items, pen caps, springs, and fasteners (1,3,6). In Muslim countries like Türkiye, adolescent girls commonly aspirate headscarf needles due to their habit of holding them in their mouths while adjusting their headscarves (8,30,36). In our study, dried nuts were the most frequently aspirated objects in the ≤3-year-old group, stationery items in school-aged children (8-10 years), and headscarf needles in children >10 years. Notably, four children <10 years of age aspirated headscarf needles while their mothers were tying their headscarves.

Complications associated with FBA or removal occur in 1-14.6% of cases. Failure to remove FBs may result in bronchospasm, hypoxia, laryngeal edema, pneumomediastinum, and pneumothorax (5,7,10,37). Most critically, hypoxic-ischemic encephalopathy can be fatal (3-5,10). Liang et al. (38), in their series of 2000 cases, reported 15 fatalities, seven of which were due to acute obstructive asphyxia during aspiration, while the remaining eight resulted from chronic asphyxia and respiratory circulatory failure. In our study, some cases developed bronchospasm, laryngeal edema, and desaturation following bronchoscopy; however, all responded to medical treatment, and no mortality was observed.

This study has certain limitations. It is a single-center, retrospective study conducted at a single hospital.

CONCLUSION

Delayed diagnosis of FBA increases the risk of severe complications, including recurrent lung infections, lung abscess, and bronchiectasis. In some cases, thoracotomy may be required to remove the FB, and lung resection may become necessary due to irreversible lung damage. Therefore, we emphasize the critical importance of prevention, early diagnosis, and timely intervention in cases of FBA.

To reduce the risk of aspiration, children under the age of 3 should be fed in accordance with their developmental stage, and foods with a high risk of aspiration should be provided in safe, child-friendly forms. Small objects should be kept out of children's reach, and toys should be selected based on their durability and safety features. Additionally, warning labels regarding choking hazards should be placed on toys. Educational programs should be developed, particularly targeting parents, to increase awareness and prevention. School-age children and teachers should also be informed about the risks and preventive measures.

Considering the significant Muslim population worldwide, headscarf needle aspiration presents a serious health concern. We recommend that headscarf needles be designed with larger heads to prevent accidental aspiration. Women should exercise caution while using headscarf needles and should avoid holding them in their mouths while wearing a headscarf.

A detailed history of FBA should be meticulously obtained. In cases with a history or suspicion of aspiration, bronchoscopy should be performed promptly under appropriate conditions to facilitate early diagnosis and treatment.

Ethics Committee Approval: The study was approved by the Clinical Research Ethics Committee of Keçiören Training and Research Hospital (09.03.2021, 2249).

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