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Araştırma/*Research Article*

Tracheobronchial Foreign Bodies in Children: A Strong History Associated with Plain Chest Radiography Findings Leads to Bronchoscopy

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Çocuklarda Trakeobronşiyal Yabancı Cisimler: Akciğer Radyografisi Bulguları ile İlişkili Güçlü Bir Hikaye Bronkoskopiye Yol Açıyor

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ABSTRACT

Objective: *History and chest x-ray are the main diagnostic tools in children with foreign body aspiration (FBA). The study aims to evaluate clinical, radiological, and bronchoscopic findings associated with early and delayed diagnosis of FBA.*
Methods: *The records of 249 children having bronchoscopy for suspected FBA were analyzed in three groups as negative bronchoscopy for FBA (group I), early diagnosis (group II), and delayed diagnosis (group III).*
Results: *Choking episodes, coughing, and decreased breath sounds were determined significantly in FBA. The percentage of radiopaque FBs was 6.2%. Emphysema in groups II and III; atelectasis and pneumonia in group III were significantly higher on chest x-ray. Pneumonia and significant inflammation found during bronchoscopy were prominent in group III. FBs were mostly vegetable origin and the majority were found in the bronchus, more on the right side. FBs were successfully removed by rigid bronchoscopy except one having thoracotomy.*
Conclusion: *Review of the literature, our current (2010-2019) and previous (1994-2003) studies designed in the same group structure showed that choking episode associated with a radiopaque FB leads to bronchoscopy. Emphysema and atelectasis are also valuable for early diagnosis. Regardless of radiological findings, bronchoscopy should be considered in patients with a strong history.*

Keywords: *foreign bodies, trachea, bronchi, chest x-ray, bronchoscopy, children*

ÖZ

Amaç: *Öykü ve akciğer grafisi, yabancı cisim aspirasyonu (YCA) olan çocuklarda temel tanı araçlarıdır. Çalışma erken ve gecikmiş YCA tanısı ile ilişkili klinik, radyolojik ve bronkoskopik bulguları değerlendirmeyi amaçlamaktadır.*
Yöntem: *YCA şüphesi nedeniyle bronkoskopi yapılan 249 çocuğun kayıtları, YCA için negatif bronkoskopi (grup I), erken tanı (grup II) ve gecikmiş tanı (grup III) olmak üzere üç grupta incelendi.*
Bulgular: *YCA'da boğulma atakları, öksürük ve solunum seslerinde azalma anlamlı olarak belirlendi. Radyoopak YC'lerin yüzdesi % 6.2 idi. Grup II ve III'te amfizem; Grup III'te atelektazi ve pnömoni akciğer grafisinde anlamlı derecede yüksekti. Bronkoskopi sırasında saptanan pnömoni ve belirgin inflamasyon Grup III'te belirgindi. YC'ler çoğunlukla bitkisel kökenlidir ve çoğunluğu bronşta, daha çok sağ tarafta bulunmuştur. YC'ler, torakotomi olan biri dışında rijit bronkoskopi ile başarıyla çıkarıldı.*
Sonuç: *Literatür taraması, aynı grup yapısında tasarlanan mevcut (2010-2019) ve önceki (1994-2003) çalışmalarımız radyoopak YC ile ilişkili boğulma epizotunun bronkoskopiye yol açtığını göstermiştir. Anfizem ve atelektazi de erken teşhis için değerlidir. Radyolojik bulgulardan bağımsız olarak, güçlü öyküsü olan hastalarda bronkoskopi düşünülmelidir.*

Anahtar kelimeler: *yabancı cisim, trakea, bronş, akciğer grafisi, çocuk*

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INTRODUCTION

Foreign body aspiration (FBA) is one of the most important causes of accidental deaths in childhood; It is the most common cause of sudden upper respiratory tract obstructions [1-4]. Most of the cases are children between the ages of 1-3 years and 77% of patients with FBA were aged ≤3 years [5]. The degree of obstruction and the resulting asphyxia varies according to the age of the child, the size of the airway, and the aspirated foreign body [6].

History, physical examination, and plain chest radiography are the diagnostic tools for FBA. Complications are rarely encountered in early diagnosis and treatment. FBA may remain undetected due to underappreciated symptoms by parents, atypical history, or overlooked clinical and radiological findings. Patients with undetected FBA might be treated as having some other pathologies such as asthma and recurrent pneumonia. If the diagnosis is late, granulation develops around the foreign body (FB) which may cause post obstructive pneumonia, atelectasis, and bronchiectasis [7,8]. Diagnosis and management are highly challenging in such cases.

The type of FB varies according to age, geographical region, cultural and socioeconomic characteristics. FBA treatment is the removal of the material by bronchoscopy. Mortality rates have declined dramatically with technological advances in the diagnostic and management modalities.

In this study, demographic features, clinical, radiological, and bronchoscopic findings of the patients with FBA were evaluated. The data of the patients who had delayed diagnosis was compared with the data of the patients with earlier diagnosis of FBA within 72 hours of aspiration and the patients with negative bronchoscopy for FB. In our previously published study, the data of the patients having FBA between 1994 and 2003 were evaluated in the same group structure [9]. The purpose of the study is to evaluate our findings with a review of the literature and comparison of the data of our current (2010-2019) and previous (1994- 2003) studies designed in the same group structure.

MATERIALS and METHODS

Retrospective analysis of 249 children who were suspected to have FBA and had bronchoscopy from January 2010 to May 2019 was performed. The study was approved by the Ethics Committee (Noninvasive, Clinical Retrospective Research. Number 2019-334). The patients were evaluated in three groups. Age, gender, symptoms and signs, duration of symptoms before bronchoscopy, radiological and bronchoscopic findings including the type and the location of the FB were analyzed. All suspected cases had a bronchoscopy and the diagnosis of aspiration was confirmed by bronchoscopic examination. Thoracotomy was needed only in one patient with FBA. Patients with negative bronchoscopy findings for FB were in group I (n=71). Group II and III had patients with FBA. In group II (n=93), the diagnosis of FBA was early within 72 hours and the diagnosis was delayed beyond 72 hours of aspiration in group III (n=85).

The statistical analysis was performed with SPSS for Windows 21.0. Shapiro Wilks test was used to investigate the suitability of the data for normal distribution. The Nonparametric Kruskal Wallis test was used for comparisons between the groups. Chi-square tests were used in the analysis of the crosstabs. P values less than 0.05 were considered statistically significant.

RESULTS

Clinical findings

The demographic and clinical features of the patients were shown in table 1. In terms of gender distribution, the difference was significant in favor of boys in all three groups ($p<0.001$). The mean age difference was not significant between the groups. The number of patients under the age of one was significantly higher in group I. The number of patients between 1 to 3 years of age was significantly higher in all three groups ($p<0.001$).

Choking episode, coughing, and decreased breath sound were significantly higher in group II and III compared with group I, but the difference was not significant between groups II and III. The number of patients with clinical pneumonia findings was

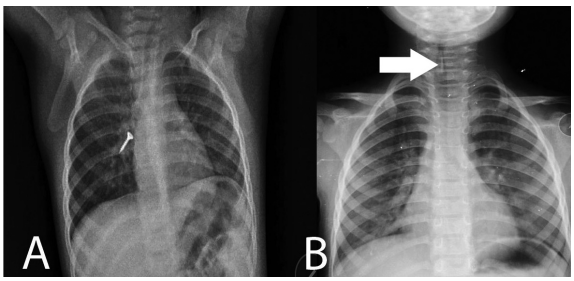

Figure 1. Radiopaque foreign body, chest X-ray (1A) showing a screw in the right bronchus. A radiopaque chicken bone located in the trachea (1B).

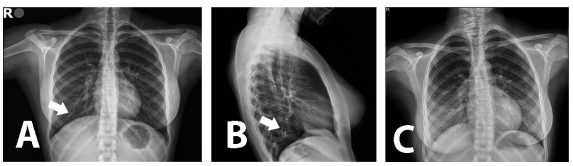

Figure 2. Posteroanterior (2A) and lateral chest X-ray (2B) show a deeply inserted radiopaque needle that can be only removed thoracotomy from the right lower bronchus. Normal postopertive radiologic findings in Figure 2C.

significantly higher in group III and was not detected in group II. There was no significant difference between the groups in terms of wheezing.

Radiological findings

A plain chest x-ray was performed in all suspected cases. Paired inspiratory and expiratory films were not routinely feasible due to a lack of cooperation. Radiographs of all 249 patients were available for the review. The radiological findings were shown in table 2. The number of normal radiographs was significantly less in group III compared with the other groups (P<0.05). Radiopaque FBs were seen in 6.2% of patients with FBA (Figure 1). The number of radiopaque FBs was significantly higher in group II than group III (P<0.05). Emphysema was significantly more common in children with FBA groups. The majority of emphysematous changes were unilateral. Atelectasis and pneumonia were significantly higher in group III than group I and group II (P<0.001). There was no bilateral atelectasis. Chest fluoroscopy was not performed.

Computed tomography (CT) was performed in three patients with atypical clinical and radiological findings. The retrospective evaluation showed those three patients were in group I, and FB was not detected by bronchoscopy. One had pneumococcal pneumonia and the other two had atelectasis caused by intrabronchial mucous plug obstruction.

Bronchoscopy findings

Aspirated FB types were shown in table 3. Most of the aspirated FB were radiolucent (93.8%) and were vegetable in origin (79%). Peanut was the most common FB aspirated (20.2%).

Radio-opaque foreign bodies were very few (6.2%). They were mostly metal objects (Figure 1A). The number of the radio-opaque FBA was significantly

Table 1. Clinical data of the groups.

	G I (n=71)	G II (n=93)	G III (n=85)	Total (n=249)
Age, months: MED(Q1;Q3)	20 (13;39)	22 (16;28)	20 (15;28.5)	20 (14;29)
Age distribution				
<1 years old	18,3% (n=13)	9,7% (n=9)	8,2% (n=7)	%11,6% (n=29)
1-3 years old	56,3% (n=40)	68,8% (n=64)	72,9% (n=62)	66,7% (n=166)
>3 years old	25,4% (n=18)	21,5% (n=20)	18,8% (n=16)	%21,7% (n=54)
Gender F/M	31/40	32/61	27/58	90/159
Choking episode	8,5% (n=6)	92,5% (n=86)	81,2% (n=69)	64,7% (n=161)
Cough	66,2% (n=47)	95,7% (n=89)	97,6% (n=83)	88% (n=219)
Wheezing	53,5% (n=38)	41,9% (n=39)	36,5% (n=31)	43,4% (n=108)
Decreased breath sound	18,3% (n=13)	63,4% (n=59)	52,9% (n=45)	47% (n=117)
Pneumonia	4.2% (n=3)	0	17,6% (n=15)	6% (n=15)

Table 2. Radiological findings on plain chest x-rays.

	G I (n=71)	G II (n=93)	G III (n=85)
Visible foreign body	0	12,9% (n=12)	1,2% (n=1)
Emphysema	4,2% (n=3)	8,6% (n=8)	18,8% (n=16)
Atelectasis	2,8% (n=2)	1,1% (n=1)	12,9% (n=11)
Pneumonia	4,2% (n=3)	0	17,6% (n=15)
Normal radiograph	88,7% (n=63)	90,3% (n=84)	51,8% (n=44)

Table 3. Foreign body types.

Group	seed	peanut	hazelnut	walnut	RC	OFo	PO	Coagulum
NRFB								
Group II (n=83)	8	21	9	12	8	17	6	2
Group III (n=84)	13	15	10	8	9	11	2	16
RFB	needle	tooth	screw	bone	OMO			
Group II (n=10)	5	1	1	1	2			
Group III (n=1)				1				

NRFB: Non- Radiopaque foreign bodies; RC: Roasted chickpea; OFo: Other Food; PO: Plastic objects; RFB: Radiopaque foreign bodies; OMO: other metal objects

lower in the group with delayed presentation. A chicken bone lodged for four days in the trachea was the only radio-opaque object in this group (Figure 1B).

Table 4 shows the location of FBs. The majority of the foreign bodies were found in the bronchus and there was a statistically significant difference for the distribution to the left and the right sides for both groups ($P<0.05$). The right side was more common than the left side.

Mucous plugs together with mucosal edema or hyperemia were found in 53.5% (n=38) of the patients in group I. Together with FB, edema, or hyperemia like minor mucosal reactions were observed in the majority of the patients in group II. Significant tissue reaction and granulation around the FB together with copious purulent secretion were determined in 61.2% (n=52) of the patients in group III. The number of patients who were hospitalized firstly by pediatricians due to respiratory symptoms was significantly higher in group I and III compared with group II. Pediatricians asked for diagnostic bronchoscopy in those cases. Most of the patients in group II were diagnosed early in the emergency department, directly hospitalized in pediatric surgery, and had bronchoscopy. Early detection and removal of FBs were succeeded in this group. In one of the patients in group II, radio-opaque foreign body detected on the chest x-ray could not be found by bronchoscopy (Figure 2) and thoracotomy was performed following a thoracoscopic exploration; a needle was found and retrieved from the right lower lobe bronchus.

In all patients in group II and III except one having thoracotomy, the FB was successfully removed by rigid bronchoscopy under general anesthesia. In group II, the majority of the patients were hospitalized as outpatients and the patients who were under one-year-old (9.7%) have stayed overnight. The duration of hospitalization ranged from 2 -5 days in group III.

DISCUSSION

Foreign body aspiration is a fatal condition that requires urgent intervention in children. The frequency of aspiration increases especially under three years old age. Children in this age group tend

Table 4. Foreign body locations.

Group	Trachea	RB	LB	Diffuse*	Larynx
Group II (n=93)	%15,1 (n=14)	%46,2 (n=43)	%29 (n=27)	%6,5 (n=6)	%3,2 (n=3)
Group III (n=85)	%7,2 (n=6)	%51,8 (n=43)	%49,4 (n=42)	%17,6 (n=15)	0
Total (n=178)	%11,2 (n=20)	%48,3 (n=86)	%38,8 (n=69)	%11,8 (n=21)	%1,7 (n=3)

RB: right bronchus; LB: left bronchus

to put objects into their mouths; crying and laughing during inspiration also increase the risk of aspiration [10]. In our study, 166 (66.7%) of 249 patients who underwent bronchoscopy were between 1-3 years of age. In our previous study, 129 (60.3%) of 214 patients who underwent bronchoscopy were between 1-3 years of age [9]. In our study, FBA occurred more in boys (63.9%) than in girls (36.1%), consistent with our previous study and other reports [11]. Similar to our previous study, we found that the probability of negative bronchoscopy in suspected cases was significantly higher under one year of age. The airway is narrower in this age group comparing with older ages and mucous plugs together with mucosal edema or hyperemia may mimic FBA under one year of age.

Witnessed aspiration associated with choking episode is a significant independent predictor of FBA [12]. Unclear history of aspiration and choking may cause a delay in the diagnosis and management [9,13]. In such cases, the physician may consider other pediatric respiratory pathologies such as pneumonia, bronchiolitis, or asthma, and misdiagnosis may lead to much worse condition and the patient may even die. In our study, %92.5 of patients in group II and %81.2 of patients in group III had a choking episode; it was %86.4 and %77.7 respectively in our previous study [9]. Our findings in both studies may suggest that the history of choking episode leads to an early diagnosis.

Other common symptoms and signs of FBA are persistent coughing, wheezing, and decreased breath sound [14,15]. While coughing is the predominant symptom for older children; persistent crying, wheezing, stridor, seizures, and loss of consciousness are most frequently observed among infants [16]. FB location, how much it obstructs the respiratory tract, and duration of lodgment all determine the severity of the symptoms and signs. Inflammation, pneumonia, and persistent cough attacks occur due to an embedded FB [17]. In our present and previous studies, coughing and decreased breath sounds were significantly higher in early and delayed FBA groups. Pneumonia was prominent in patients with delayed diagnosis in both previous and present studies (1994-2003 and 2010-2019). Inflammation, increased mucosal reaction with granulation, and secretion caused by embedded FB may explain why pneumonia was significantly found in this group of patients. Although there is no FB, mucous plugs may mimic the clinical and radiological findings of FBA. In such cases, especially in patients with nonspecific persistent signs and symptoms, pediatricians may ask for a bronchoscopy. In our previous study, the number of patients having pneumonia associated with negative bronchoscopy for FB was significantly high, but the number decreased dramatically in our present study, this may suggest that what we have learned from the past experience in diagnosis and management improved the differential diagnosis of pneumonia associated pathologies.

The type of aspirated foreign body depends on the culture and eating habits of society [18]. Families and caregivers should be educated on which objects at what age have a risk for aspiration. In our previous and present studies, most of the aspirated FBs were dry roasted seeds and nuts for snacks [9]. Sunflower seeds and peanut were the most common FBs aspirated. In a study by Deskin et al., 80% of the aspirated foreign bodies were reported to be food and radiolucent objects [15]. The inflammatory response is more significant when food particles are aspirated. Vegetables trigger more inflammatory responses. Therefore, they create edema and obstruction in the distal airways [9].

Foreign bodies settle in the bronchi in % 80-90% of the patients. Since the left main bronchus is narrower and its deviation from the trachea is considerably greater than the right, the foreign bodies most commonly get into the right main bronchus. In our previous and present studies, we found that most of the foreign bodies were located in the right main bronchus. Depending on the position of the child during aspiration, a high number of FB lodgment in the left main bronchus was also reported [19]. The majority of the FBs could be retrieved by bronchoscopy, but the physician should be ready for thoracoscopy or thoracotomy for a FB located deep in the distal bronchus. In one of our patients, a metal needle was lodged in the right lower lobe bronchus and thoracotomy was needed to remove the object. The aspirated radiopaque FBs could be easily detectable on plain chest x-ray. This enables early and definitive diagnosis and treatment. Thus, complications are prevented. In our study, 6.1% of all FBs were radio-opaque. The percentage of radio-opaque FBs was significantly higher in our previous study as 19.7%. The ratio of the early diagnosed patients having FBA (group II) to the patients with delayed diagnosis (group III) was 1.1 (93/85) in the current study and it was 4.63 in the previous one [9]. Our data from both studies may suggest that a significant decrease in the percentage of the radio-opaque FBs correlates with an increase in the percentage of the patients with delayed diagnosis. If a strong history for FBA is present, but the plain chest radiograph does not show a radio-opaque object or indirect signs indicating the presence of a radiolucent FB, the physician should consider bronchoscopic exploration to prevent misdiagnosis and consequences of an embedded FB. The decision-making process in diagnosis and treatment of such cases is challenging but if there is a clear history even not supported by radiological investigations, early bronchoscopic evaluation should be a next step in the management. If the physician remains indecisive despite the obvious history, a FB left in situ may cause an intense inflammatory response and consolidation distal to the obstruction [9,12].

Unilateral emphysema, atelectasis, and pneumonia might be found as indirect radiological findings of a radiolucent FB on chest x-ray. Obstructive emphysema occurs with hyperinflation due to a check valve obstruction [20]. In both past and present studies, emphysema was significantly more common in children with FBA groups. Emphysema may appear in the early phase of FBA; if FB remains longer, atelectasis and pneumonia may develop. Embedded FB may cause complete distal endobronchial obstruction. Mucosal inflammation and viscous secretion aggravate the pathology and may result in atelectasis and pneumonia [9,21]. Plain chest radiography shows atelectasis in approximately 25% of the patients with FBA [22,23]. Pneumonia due to persistent bronchial obstruction occurs in 9-26% of cases [22-24]. In our study, pneumonia was not determined in the radiographs of the patients with early diagnosis of FBA and it was significantly higher in the patients with delayed diagnosis (17.6%) and the number of radiographs with a diagnosis of atelectasis and pneumonia was more common in the patients with delayed diagnosis. Our findings may suggest that an early bronchoscopic examination should be considered in a case with a recent strong history associated with emphysema on the chest x-ray, and all indirect radiological findings of a radiolucent FB including emphysema, atelectasis, and pneumonia should alert the physician to suspect FBA with a delayed presentation.

In our study, the chest x-ray was the main radiological investigation. If a patient has atypical clinical and radiological findings, the physician may ask for chest fluoroscopy or computed tomography (CT). Fluoroscopy may show an aspirated object, air trapping, mediastinal shift to the opposite side, and paradoxical diaphragmatic movement caused by FB triggering inhibitory reflex [9,25]. In our previous study, we performed chest fluoroscopy in 10 patients with negative radiographs [9]. Only positive findings were air trapping and mediastinal shift shown in 8 patients with FBA. All patients having fluoroscopy had some significant clues in their histories and/or physical examination, bronchoscopy was performed and FB was removed. In our present study, there is no record of chest fluoroscopy. With our previous findings, we decided not to perform fluoroscopy because it did not significantly change the way we approach patients. The radiation exposure should also be considered.

CT is another imaging procedure that might be

preferred for the diagnosis of a radiolucent foreign body [26]. It may detect the object and location of FB lodgment in suspected cases [27]. The physician should have a concern about using CT for the diagnosis of FBA in children. The radiation exposure has the potential risk for developing future malignancies. We do not prefer the routine use of CT for the diagnosis of FBA. CT may help with the differential diagnosis of suspected cases having atypical clinical presentations and prolonged and inconclusive diagnostic studies. In our study, CT was performed only in three patients with atypical history, and FB was not detected by bronchoscopy in those patients.

Children with FBA may have a clinical presentation that is easy to diagnose or highly complex and atypical. A combination of a witnessed episode of choking, transient cyanosis, coughing, unilateral decreased breath sound, and radiopaque foreign body on chest x-ray is easy to diagnose. Indirect radiological findings of a radiolucent FB on chest x-rays such as unilateral emphysema or atelectasis are also valuable if associated with a strong history. The case is highly challenging and difficult to diagnose if the patient has an atypical or misleading history together with nonspecific plain chest radiography. In such cases, misdiagnosis such as asthma, pneumonia, croup, and reactive airway diseases may lead to a delayed diagnosis. The physician must maintain a high index of suspicion and if there is no significant clue, a more extensive history, and physical examination together with CT evaluation could be obtained. Regardless of the chest x-ray and CT findings, when FBA is suspected according to the history, a bronchoscopic examination should be considered to prevent morbidity and mortality caused by complications of delayed diagnosis.

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