Foreign Body Aspiration in Childhood

Evaluation of Diagnostic Parameters

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Background: Foreign body aspiration (FBA) is one of the most important preventable causes of childhood mortality and morbidity.

Objective: The aim of this study was to define the clinical and radiological features of FBA and investigate the diagnostic value of various parameters used to diagnose FBA.

Methods: The medical records of 147 children who were admitted to the hospital with a diagnosis of suspected FBA were examined. The sensitivity and specificity of the parameters used for the diagnosis of FBA and their predictive values were calculated.

Results: Of the patients, 75.5% were younger than 3 years, and 61.2% were male. Peak incidence was found in 18 months. A negative bronchoscopy rate of 19.7% was found, and 92.6% of these patients were younger than 3 years. The parameter with the highest diagnostic value was the presence of aspiration history (the sensitivity and positive and negative predictive values were 97%, 89%, and 80%, respectively). No significant difference was found in the classic triad of FBA (sudden onset of cough, wheezing, and unilaterally decreased breath sounds) between patients with and without FBA. The specificity and positive predictive value of the classic triad were high, and the sensitivity and negative predictive value were low (85% and 78%, and 13% and 19%, respectively).

Conclusions: Especially, male children younger than 3 years have an increased risk of FBA. Neither clinical symptoms nor the radiological findings alone are sufficiently specific and sensitive in diagnosing FBA. The most important factor for diagnosis is the presence of aspiration history.

Key Words: foreign body aspiration, diagnostic parameters

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Tracheobronchial foreign body aspiration (FBA) is a common cause of respiratory emergency in early childhood. An undiagnosed and retained foreign body (FB) may result in severe early and late complications such as asphyxia, pneumonia, airway obstruction, atelectasis or bronchiectasis, and death.[1–3] Early diagnosis and removal of FB are extremely important to prevent these complications.[4] Despite modern diagnostic advances, in infants and young children, difficulty in diagnosing an airway FB still remains.[4] Studies disagree about the diagnostic value of parameters used for diagnosing FBA. The aims of this study were to define the clinical and radiological features of patients with FBA and to investigate the role of different parameters in diagnosing potential FBA before bronchoscopy.

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METHODS

We conducted a study of 152 children who were hospitalized with suspected FBA who underwent bronchoscopy or who had the FB removed spontaneously or after Heimlich maneuver in our hospital between January 2003 and December 2008. Information regarding age, sex, habitat (urban or rural area), presence of aspiration history, elapsed time from aspiration to diagnosis, complaints, physical examination and radiological findings, bronchoscopy results, type and anatomic localization of aspirated FB, length of hospital stay, and clinical results was extracted from the medical records for each patient. Four patients with mental motor retardation and 1 patient who underwent bronchoscopy in another hospital were excluded from the study. The patients were divided into 2 groups: older than 3 years and younger than 3 years; the latter was divided into 2 groups according to whether an FB was detected or not. All the patients underwent posterior-anterior chest radiography at admission to the emergency department (ED). Bronchoscopy was performed with a rigid bronchoscope under general anesthesia. Statistical analysis was conducted using the Statistical Package for the Social Sciences for Windows 15.0 version software (Yuksel Terzi, Samsun, Turkey). The χ^2 and Fisher exact tests were used to compare the difference between the frequency rates of categorical data. Numeric data appropriate to normal dispersion were given as mean (SD); not appropriate to normal dispersion was given as median (minimum-maximum). Student t test was used to compare the difference between the averages of data appropriate to normal dispersion, and the Mann-Whitney U test was used for data not appropriate to normal dispersion. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for the clinical and radiological parameters and for their different combinations. Also, the correlation between these parameters and presence of the FB was evaluated using binary logistic regression analysis. These parameters included history of acute choking/coughing, clinical signs and symptoms, or radiological findings. $P < 0.05$ was accepted as significant.

RESULTS

Relevant characteristics of the patients are shown in Table 1. Annually, the average number of pediatric patients hospitalized with suspected FBA in our hospital for the mentioned period was 24.5 (SD, 7.5) (range, 18–36); the rate of these patients to all patients admitted to ED was 0.24%. The most common submission months were October, December, November, and September (21.1%, 10.2%, 9.5%, and 9.5%, respectively).

The most common complaints were persistent cough (81.0%), difficulty breathing (60.0%), wheezing (51.8%), and cyanosis (39.4%). Nonspecific symptoms such as fever and vomiting were found in 15.5% and 13.9% of patients, respectively. One hundred twenty-two patients (89.1%), themselves or their families, reported a positive history for FBA. The most common pathologic physical examination findings were unilaterally decreased breath sounds, wheezing, and tachypnea (57.7%, 27.0%, and

TABLE 1. Characteristics of Study Patients

Sex	90 (61.2%) male, 57 (38.8%) female, male/female ratio 1.6:1
Age, mo	Median age 22 (range, 7–192) mo, median age of males was lower than that in females (18 and 25, respectively) ($P < 0.01$). Peak incidence was 18 mo
Age group	111 (75.5%) patients were <3 y and others >3 y; 87.1% of all patients were <7 y. Mostly, patients between ages of 1 and 2 y were hospitalized. It is followed by patients <1 y and between ages of 2 and 3 y (respectively, 49.0%, 15.0%, and 11.6%)
Living area	Urban: 54 patients (36.7%)
	Rural area: 93 patients (63.3%)
Elapsed time	0–24 h: 109 (74.1%) patients; 44.9% (n = 66) of the all patients were admitted within the 6 h following the complaints
	1–7 days: 25 (17.1%) patients
	>7 days: 13 (8.8%) patients

16.8%, respectively). Sudden onset of cough, wheezing, and unilaterally decreased breath sounds, named as the classic triad of FBA, were found in only 19 patients (13.9%). Pathologic findings on chest radiography were detected in 96 patients (70.1%). The most common radiological findings were unilateral air trapping (34.3%), atelectasis (16.1%), and radiopaque FB (14.6%). Of the patients, 64.6% had at least 1 of these findings.

In 4 patients who had an aspirated FB removed spontaneously and in 1 patient in whom it was removed by the Heimlich maneuver, bronchoscopy was not applied. In addition, 5 patients' parents did not give permission for bronchoscopy. Therefore, these patients were followed up clinically. One hundred thirty-three (97.1%) of 137 patients underwent bronchoscopy once, and 4 patients (2.9%) underwent it twice; FBA was detected in 110 (80.3%) of these patients. Bronchoscopy was applied to 36.5% of the patients within the first 6 hours after their arrival at the hospital, and in 90.5% of the patients, bronchoscopy was performed within the first 24 hours. In 2 cases (1.5%), 3 days elapsed between hospitalization and bronchoscopy. The distribution of the patients with detected FB according to age and sex is given in Table 2.

The sensitivity, specificity, and predictive values of history, physical examination, and radiological findings are given in Table 3.

The sensitivity, specificity, and predictive values of the various parameters used in diagnosing FBA and their combinations in all patient and according to age groups (<3 and >3 years of age) are given in Tables 4 and 5. Multivariate analysis showed that history of aspiration was an independent predictor in children after adjustment for other parameters especially in those younger than 3 years (Table 6).

In our study, the negative bronchoscopy rate was 19.7%. Of these patients, 51.9% were younger than 18 months, and 92.6% were younger than 3 years. Only 2 patients who did not have an FBA (7.4%) were older than 3 years. Patients with negative bronchoscopy were followed up clinically. None of these patients were readmitted for any complaints associated with FBA. The rate of negative bronchoscopy was 24.3% and 5.9% for the patients younger and older than 3 years, respectively ($P < 0.05$). Generally, the FBs were removed with bronchoscopy (93.6%). Of the patients' FBs, 98.1% were removed in the first attempt, and 2.9% in the second attempt. The thoracotomy rate in our study was 1.8% (2 patients). One of the patients, in whom the FB could not be removed on the first try, had the FB removed spontaneously by coughing before the second attempt. In 4 patients (3.6%), the FB could not be removed because of its small size and distal localization. These patients were followed up clinically and with chest physiotherapy. None of these patients were readmitted for any complaints associated with FBA after being discharged from the hospital.

Foreign bodies were mostly detected in the right bronchial system (43.6%). The other localizations detected were the left bronchial system, the trachea, and the larynx. In one patient, although the radiopaque FB was on the left during admittance, in x-ray control and bronchoscopy, the FB was defined on the right. Of the FBs removed, 72.6% were organic, and 27.4% were inorganic. Organic bodies were common in patients younger than 3 years, and inorganic ones were common in patients older than 3 years. The difference between the groups was statistically significant ($P < 0.01$). The association was independent of habitat (urban or rural area) and type of FB. Nuts were the most common FBs, and turban pins were the most common inorganic FBs. The FBs detected in our study are given in Table 7.

Length of stay in hospital was 2 days on average. Of the patients who underwent bronchoscopy, 86.1% were discharged within 3 days. Three patients (2.2%) were followed up in the intensive care unit, and one of these patients died. This patient was a 15-month-old boy. He was admitted to the hospital with sudden onset of dyspnea and cyanosis. A nut was removed by bronchoscopy from the right main bronchus at the first hour of admittance to the ED. Unfortunately, pneumothorax developed

TABLE 2. Dispersion of the Patients Who Detected Foreign Body According to Age and Sex

Age Group	Age, y	n	%	Male	Female	Male/Female Ratio
<3 y	0–1	11	10.0	55	23	2.4
n = 78 (70.1%)	1–2	56	50.9			
	2–3	11	10.0			
>3 y	3–16	32	29.1	13	19	0.7
n = 32 (29.1%)						
Total		110	100	68	42	1.6

TABLE 3. Sensitivity, Specificity, and Predictive Values of History, Physical Examination, and Radiologic Findings

Parameter	Findings	FBA Was Diagnosed (n = 110)	FBA Was Not Diagnosed (n = 27)	*P*	Sensitivity %	Specificity %	PPV %	NPV %	Likelihood Ratio
History of aspiration		107	15	<0.01	97.3	44.4	89.1	80.0	1.75
Complaints	Cough	87	24	NS	79.1	11.1	78.3	11.6	0.88
	Difficulty of breathing	66	17	NS	60.0	37.0	79.5	18.6	0.95
	Wheezing	53	18	NS	48.1	33.3	74.6	13.6	0.72
	Cyanosis	49	5	<0.01	44.5	81.5	90.7	26.5	2.40
Pathologic physical examination findings	Decreased breath sound	64	15	NS	58.2	44.4	80.0	20.7	1.04
	Wheezing	28	9	NS	24.5	66.7	75.7	18.0	0.73
	Tachypnea	19	4	NS	17.3	85.2	82.6	20.2	1.16
	Crepitant rale	17	5	NS	15.5	81.5	77.3	19.1	0.83
	Stridor	12	5	NS	11.0	81.5	70.6	18.3	0.60
	Retraction	15	1	NS	13.6	96.3	93.8	21.5	3.67
	Cyanosis	7	1	NS	6.4	96.3	87.5	20.2	1.72
Pathologic radiologic findings	Air trapping	38	9	NS	34.5	66.7	80.9	20.0	1.03
	Atelectasia	18	4	NS	16.4	85.2	81.8	20.0	1.10
	Radio opaque FB	20	0	<0.01	18.2	100.0	100.0	23.1	—*
	Mediastinal shift	8	2	NS	7.3	92.6	80.0	19.7	0.98
	Pneumonic infiltration	5	1	NS	4.5	96.3	83.3	19.8	1.21

*Likelihood ratio is not calculated.

FBA indicates foreign body aspiration; PPV, positive predictive value; NPV, negative predictive value; FB, foreign body; NS, not statistically significant.

during the bronchoscopy, and he died on the third day of admission. The mortality rate was 0.7% in our study. The other patients were discharged healthy.

DISCUSSION

As in previous studies, our study has shown that the first 3 years of life are associated with an increased risk of FBA.[1–9] This risk is more distinctive in the second year of life.[5,10,11] Research has shown that boys are more affected than girls.[2,5,7,11–13] The ratio of boys to girls was 1:6 in our study. However, we defined this ratio change in favor of girls among children older than 3 years and the most distinctive in adolescent group. We did not come across any study that compares the clinical results of FBA in relation to the urban and rural residence of the patients. In our study, the number of patients living in rural areas was higher than the number living in urban areas. However, there was no difference between groups in terms of clinical findings, bronchoscopy results, and aspirated FB. Zaupa et al[9] stated that the most frequent referral period was in December, a festival month. Tander et al,[14] on the other hand, reported that nut aspiration was most frequent during nut harvesting season, August and September. Our results showed a similarity to those of Tander et al.[14]

A history of acute choking/coughing or a witnessed aspiration episode frequency is stated in 22% to 86%.[2,3,7,10,15] This rate was higher in our study (89.1%). In previous studies, sensitivity and specificity of history of choking/coughing were found in 81% to 91% and 21% to 76% of patients, respectively.[2,16–20] Ciftci et al,[2] in addition, found the PPV of history to be higher. We found much higher sensitivity and PPV and NPV of history of choking/coughing episode. The higher frequency

TABLE 4. Sensitivity, Specificity, and Predictive Values of Various Parameters Used for the Diagnosis of FBA

Parameter	FBA Was Diagnosed (n = 110)	FBA Was Not Diagnosed (n = 27)	*P*	Sensitivity %	Specificity %	PPV %	NPV %	Likelihood Ratio
History of aspiration	107	15	<0.01	97.3	44.4	89.1	80.0	1.75
Classic triad	15	4	NS	13.6	85.2	78.9	19.5	0.91
Existence of pathologic physical examination findings	91	24	NS	82.7	11.1	79.1	13.6	0.93
Existence of pathologic radiological findings	81	15	NS	73.6	44.4	84.4	29.3	1.32
History + physical examination	88	13	0.01	80.0	51.9	87.1	38.9	1.66
History + radiology	79	7	<0.05	71.8	74.1	91.9	39.2	2.77
History + physical examination + radiology	62	7	<0.05	56.4	74.1	89.9	29.4	2.17

FBA indicates foreign body aspiration; PPV, positive predictive value; NPV, negative predictive value; FB, foreign body; NS, not statistically significant.

TABLE 5. Sensitivity, Specificity, and Predictive Values of Various Parameters Used for the Diagnosis of FBA According to Age Group

Parameter	Age, y	FBA Was Diagnosed (n = 110)	FBA Was Not Diagnosed (n = 27)	*P*	Sensitivity %	Specificity %	PPV %	NPV %	Likelihood Ratio
History	<3	76	14	<0.01	97.4	44.0	84.4	84.6	1.74
	>3	31	1	<0.01	96.8	50.0	96.8	50.0	1.94
Classic triad	<3	12	4	NS	15.4	88.4	75.0	24.1	0.96
	>3	3	0	NS	9.4	100	100	6.5	—*
Existence of pathologic physical examination findings	<3	72	22	NS	92.3	12.0	76.6	33.3	1.05
	>3	19	2	NS	59.4	0	90.5	0	0.59
Existence of pathologic radiological findings	<3	57	13	<0.05	73.1	48.0	81.4	34.4	1.41
	>3	24	2	NS	75.0	0	92.3	0	0.75
History + physical examination	<3	70	12	<0.01	89.7	52.0	85.4	61.9	1.87
	>3	18	1	NS	56.2	50.0	94.7	6.7	1.12
History + radiology	<3	55	6	<0.05	70.5	76.0	90.2	45.2	2.94
	>3	24	1	NS	75.0	50.0	96.0	11.1	1.50
History + physical examination + radiology	<3	50	6	<0.05	64.1	76.0	89.3	40.4	2.67
	>3	12	1	NS	37.5	50.0	92.3	4.8	0.75

*Likelihood ratio is not calculated.

FBA indicates foreign body aspiration; PPV, positive predictive value; NPV, negative predictive value; FB, foreign body; NS, not statistically significant.

rate of aspiration history and its diagnostic values found in our study can be related to the fact that most of the patients arrived earlier in the ED and were diagnosed.

In our study, similar to previous studies, the most frequent presenting clinical symptom was persistent cough.[4–6] Initial findings are generally nonspecific. For that reason, a diagnostic value of clinical findings alone is limited. In addition, despite FBA, there may be no pathologic finding on physical examination. Frequency of normal physical examination was reported as 41.0% to 68.8%.[2,9] In our study, this rate was 16.1%. Ciftci et al[2] reported that the rate of the presence of normal physical examination was higher in the group without FBA than with FBA. We did not find a significant difference between groups. Zaupa et al[9] found the sensitivity, specificity, PPV, and NPV of clinical findings were 50%, 78%, 54%, and 75%, respectively. Ciftci et al[2] found that the sensitivity and PPV of auscultation findings were higher (86%, 87%), and the specificity and NPV were lower (24%, 26%). We found that the specificity and NPV of pathologic physical examination findings were higher (82.7% and 79.1%, respectively).

The signs include acute coughing/choking, wheezing, and unilateral decreased breath sounds, which are defined the classic triad of FBA. At least one component of this triad is found in most cases. The positivity of the classic triad was reported as 15.7% to 25.1%.[3,5,13] We found this rate was 13.9%. No difference was found between groups with and without FBA in

TABLE 6. Results of Multivariate Analysis for Different Parameters Used in Diagnosis of FBA

Parameter	Age Group	*P*	OR	95% CI
History of aspiration	All patients	<0.01	39.2	7.4–208.2
Classic triad		>0.05		
Existence of pathologic physical examination findings		>0.05		
Existence of pathologic radiological findings		>0.05		
Elapsed time		>0.05		
History of aspiration	<3 y	<0.01	105.5	9.5–1173.1
Classic triad		>0.05		
Existence of pathologic physical examination findings		>0.05		
Existence of pathologic radiological findings		<0.05	3.28	1.02–10.5
Elapsed time		>0.05		
History of aspiration	>3 y	>0.05		
Classic triad		>0.05		
Existence of pathologic physical examination findings		>0.05		
Existence of pathologic radiological findings		>0.05		
Elapsed time				

CI indicates confidence interval; OR, odds ratio.

TABLE 7. Types of Aspirated Foreign Bodies

Kind of FB	No. Patients	%
Nut	32	30.2
Pin	12	11.3
Seed	11	10.4
Bean	7	6.6
Corn	7	6.6
Peanut	6	5.7
Pen cover	6	5.7
Pen string	4	3.8
Plastic toy pieces	3	2.8
Chestnut	3	2.8
Walnut	3	2.8
Chickpeas	3	2.8
Carrot	2	1.9
Pieces of bon	2	1.9
Cucumber	1	0.9
Coal	1	0.9
Bead	1	0.9
Paper clip	1	0.9
Earring	1	0.9
Total	106	100

terms of classic triad positivity. Similar to previous studies, we found that the sensitivity of the classic triad was low, but the specificity was high.[3,5]

Researchers have reported that shortening of the elapsed time between aspiration and appearing at the hospital was associated with a decreasing frequency of radiological findings.[13,21] In our study, although most of the patients were admitted to the hospital within 24 hours, the radiological finding frequency was higher than that in other studies. We may explain this finding by the fact that we had more patients with a diagnosis of radiopaque FB. Chest x-rays can be normal in patients with laryngeal and tracheal FB.[2,4] Bilateral cervical graphy can be helpful for the diagnosis of these patients.[22] Pathology on chest radiography was observed in only 1 of 13 patients with laryngotracheal FB. In 6 of these patients, radiopaque FB was defined on cervical radiography. The sensitivity of pathologic radiologic findings was reported as 66% to 68% and specificity as 30% to 67%.[2,5,9,16,17,19,23,24] The results of our study were similar to those of other studies (73.6% and 44.4%, respectively). In addition, similar to the findings of Midulla et al,[5] we found the PPV of the pathologic radiologic findings to be high.

Ciftci et al[2] stated that they found the sensitivity and PPV were high and that the specificity and NPV were poor when all diagnostic parameters were evaluated together. Zaupa et al[9] found that the sensitivity and specificity of the combination of clinical and the radiologic finding presence were higher than the presence of findings of clinical or radiologic finding alone. In our study, we found that, compared with the medical history, the PPV and specificity of history plus radiology and history plus physical examination plus radiology were high. To our surprise, we found that the sensitivity and NPV were poor.

The standard treatment for FBA is the bronchoscopic removal of the aspirated FB.[2] This method is effective and reliable, and the success rate is high. The FB was removed with bronchoscopy in 93.6% of the cases in our study. This result was consistent with the literature.[1–3,6,7] Researchers have reported that the need for more than one attempt was 4% to 18.9%.[1,2,4,7] In our study, this rate was 2.9%. When the complications related to bronchoscopy were compared, the results of late diagnosis were more serious. Thus, even though the clinical and radiological findings are normal, explorative bronchoscopy should be performed without delay when the presence of FBA is suspected.[2,5,6,25] Studies state that FBA may not be determined in some cases with bronchoscopy, and this situation is stated to be inevitable.[2,5,7,18,26] The negative bronchoscopy rate for previous studies was reported as 9% to 16.5%.[2,5,7,27] The rate in our study was higher than 19.7%. One of the attention-attracting points in our study was that the rate of negative bronchoscopy increased as the patient's age decreased. This result was similar to that of Ciftci et al.[2] We thought that this finding could be related to the difficulty in taking a medical history from small children and to the frequency of other airway diseases that were confused with FBA in this age group. Further diagnostic methods for FBA in this age group are needed. In addition, a scoring system based on the results of prospective studies may contribute significantly to this issue.

We found that most of the aspirated bodies were organic. The organic matter mostly aspired in our region, one of the leading nut-growing regions in the world, was nuts. This result was similar to the results of Tander et al.[14] Inorganic matter was found to be more common among children older than 3 years.

Foreign body aspiration is rare in adults. However, pin aspiration among young women is seen relatively frequently.[27–30] In Muslim countries, this can be explained by the wearing of turbans or headscarves.[26–29] Turban pins are used to attach the layers of a turban to each other to keep it in a steady position around the head. Thus, the turban must be held with both hands. Some women tend to place the pins between their lips while wearing turbans while using their hands to secure the veil.[28] Especially, in less experienced young women, maneuvers such as laughing, talking, and coughing predispose them to aspirate pins.[28] As airway obstruction does not occur with pin aspiration, usually it does not cause respiratory distress. The most common finding is choking/coughing.[26–28] Because patients can give a clear medical history and because of detection of radiopaque matter on chest radiographs, diagnosis is done usually earlier, and nearly all FBs can be removed without complication.[1,26–28] The results of our study support this information.

Zaupa et al[9] reported that, in cases of suspected FBA, the patients can be followed up without bronchoscopy if the clinical and radiologic findings are normal. Cataneo et al[6] stated that FBs with peripheral location and not removed with bronchoscopy can be left to spontaneous elimination with postural drainage. The results of our study can contribute to the literature on this issue. In our study, bronchoscopy was not performed in 10 patients. In addition, in 4 patients, the FB moved distal and could not be removed with bronchoscopy. A total of 14 patients were followed up clinically. None of these patients were readmitted for any symptoms associated with FBA. We thought that the FBs that could not be removed because of distal localization were small and organic in nature. Indeed, "wait-and-see" decision for the unremovable FBs could be dangerous for the child. This risk is higher for inorganic FBs than organic ones.

Our study was retrospective. In addition, the patients mostly arrived at the hospital during an early period of aspiration. Therefore, we could not evaluate the relationship between diagnostic parameters and time. In addition, analysis of only positive clinical and radiological findings may be caused statistical error. These were the limitations of our study.

In conclusion, FBA can be seen at all ages. However, it is more frequent in boys and in children younger than 3 years. Neither clinical symptoms nor radiological findings alone are

sufficiently specific and sensitive in the diagnosis of FBA. The most important parameter in diagnosis is the existence of aspiration history. For that reason, even though clinical and radiological findings are normal, explorative bronchoscopy should be performed without delay with every patient who has aspiration history. The rate of negative bronchoscopy is high among children younger than 3 years and in cases with suspicious aspiration history. Further supportive diagnostic tests that can increase the accuracy of the diagnosis especially for the patients in this age group are needed. In addition, in cases with low suspicion for FBA, patients can be followed up clinically without bronchoscopy to avoid the risks related with bronchoscopy.

REFERENCES

1. Karakoç F, Karadağ B, Akbenlioğlu C, et al. Foreign body aspiration: what is the outcome? *Pediatr Pulmonol*. 2002;34:30–36.
2. Ciftci AO, Bingöl-Koloğlu M, Senocak ME, et al. Bronchoscopy for evaluation of foreign body aspiration in children. *Pediatr Surg*. 2003;38:1170–1176.
3. Tomaske M, Gerber AC, Stocker S, et al. Tracheobronchial foreign body aspiration in children - diagnostic value of symptoms and signs. *Swiss Med Wkly*. 2006;136:533–538.
4. Chiu CY, Wong KS, Lai SH, et al. Factors predicting early diagnosis of foreign body aspiration in children. *Pediatr Emerg Care*. 2005;21:161–164.
5. Midulla F, Guidi R, Barbato A, et al. Foreign body aspiration in children. *Pediatr Int*. 2005;47:663–668.
6. Cataneo AJ, Cataneo DC, Ruiz RL Jr. Management of tracheobronchial foreign body in children. *Pediatr Surg Int*. 2008;24:151–156.
7. Yadav SP, Singh J, Aggarwal N, et al. Airway foreign bodies in children: experience of 132 cases. *Singapore Med J*. 2007;48:850–853.
8. Pasaoglu I, Dogan R, Demircin M, et al. Bronchoscopic removal of foreign bodies in children: retrospective analysis of 822 cases. *Thorac Cardiovasc Surg*. 1991;39:95–98.
9. Zaupa P, Saxena AK, Barounig A, et al. Management strategies in foreign-body aspiration. *Indian J Pediatr*. 2009;76:157–161.
10. Baharloo F, Veyckemans F, Francis C, et al. Tracheobronchial foreign bodies: presentation and management in children and adults. *Chest*. 1999;115:1357–1362.
11. Schmidt H, Manegold BC. Foreign body aspiration in children. *Surg Endosc*. 2000;14:644–648.
12. Swanson KL, Prakash UB, Midthun DE, et al. Flexible bronchoscopic management of airway foreign bodies in children. *Chest*. 2002;121:1695–1700.
13. Oguz F, Citak A, Unuvar E, et al. Airway foreign bodies in childhood. *Int J Pediatr Otorhinolaryngol*. 2000;52:11–16.
14. Tander B, Kirdar B, Aritürk E, et al. Why nut? The aspiration of hazelnuts has become a public health problem among small children in the central and eastern Black Sea regions of Turkey. *Pediatr Surg Int*. 2004;20:502–504.
15. Mu L, He P, Sun D. Inhalation of foreign bodies in Chinese children: a review of 400 cases. *Laryngoscope*. 1991;101:657–660.
16. Hoeve LJ, Rombout J, Pot DJ. Foreign body aspiration in children. The diagnostic value of signs, symptoms and pre-operative examination. *Clin Otolaryngol Allied Sci*. 1993;18:55–57.
17. Barrios Fontoba JE, Gutierrez C, Lluna J, et al. Bronchial foreign body: should bronchoscopy be performed in all patients with a choking crisis? *Pediatr Surg Int*. 1997;12:118–120.
18. Zaytoun GM, Rouadi PW, Baki DH. Endoscopic management of foreign bodies in the tracheobronchial tree: predictive factors for complications. *Otolaryngol Head Neck Surg*. 2000;123:311–316.
19. Martinot A, Closset M, Marquette CH, et al. Indications for flexible versus rigid bronchoscopy in children with suspected foreign-body aspiration. *Am J Respir Crit Care Med*. 1997;155:1676–1679.
20. Ayed AK, Jafar AM, Owayed A. Foreign body aspiration in children: diagnosis and treatment. *Pediatr Surg Int*. 2003;19:485–488.
21. Eren S, Balci AE, Dikici B, et al. Foreign body aspiration in children: experience of 1160 cases. *Ann Trop Paediatr*. 2003;23:31–37.
22. Foreign bodies in children. Available at: http://www.uptodate.com/online_Airway. Accessed June 2010.
23. Silva AB, Muntz HR, Clary R. Utility of conventional radiography in the diagnosis and management of pediatric airway foreign bodies. *Ann Otol Rhinol Laryngol*. 1998;107:834–838.
24. Svedstrom M, Puhakka H, Kero P. How accurate is chest radiography in the diagnosis of tracheobronchial foreign bodies in children? *Pediatr Radiol*. 1989;19:520–522.
25. Mantor PC, Tuggle DW, Tunell WP. An appropriate negative bronchoscopy rate in suspected foreign body aspiration. *Am J Surg*. 1989;158:622–624.
26. Kaptanoglu M, Nadir A, Dogan K, et al. The heterodox nature of "turban pins" in foreign body aspiration; the central Anatolian experience. *Int J Pediatr Otorhinolaryngol*. 2007;71:553–538.
27. Hasdiraz L, Bicer C, Bilgin M, et al. Turban pin aspiration: non-asphyxiating tracheobronchial foreign body in young Islamic women. *Thorac Cardiovasc Surg*. 2006;54:273–275.
28. Al-Sarraf N, Jamal-Eddine H, Khaja F, et al. Headscarf pin tracheobronchial aspiration: a distinct clinical entity. *Interact Cardiovasc Thorac Surg*. 2009;9:187–190.
29. Kolbakır F, Keçeligil HT, Ankan A, et al. Yabancı Cisim Aspirasyonları Bronkoskopi Yapılan 152 Olgunun Analizi. *Turk J Thorac Cardiovasc Surg*. 1995;3:117–120.
30. Sucu N, Aytaçoğlu B, Özgülder A, et al. Foreign body aspirations in children: a review of our experience in 75 cases. *Turk J Thorac Cardiovasc Surg*. 2002;10:155–159.