

Foreign Body Aspiration in Children with Focus on the Role of Flexible Bronchoscopy: A 5 Year Experience

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ABSTRACT: **Background:** Foreign body aspiration (FBA) is common in the pediatric population and if not diagnosed and treated properly can lead to major complications. **Objectives:** To define the clinical and radiological features of aspirated foreign bodies, characterize the incidence of FBA among the Israeli-Arab population, and evaluate flexible bronchoscopy as a diagnostic tool prior to performing rigid bronchoscopy. **Methods:** We reviewed the e-files of 115 children who underwent bronchoscopy for suspected FBA between January 2006 and December 2010 in the pediatric department of the St. Vincent French Hospital, Nazareth. **Results:** We identified 44 patients (38.3%) who had foreign body aspiration (mean age 31.2 ± 29 months, males 64%). Organic-type foreign body was seen in 70% of cases and location was equally distributed. Statistically significant correlations were found between the presence of a foreign body and a history of choking, abnormal lung auscultation, and abnormal chest X-ray ($P < 0.05$). The rate of negative finding in rigid bronchoscopy in our study was as low as 15% (in only 8 of 52 rigid bronchoscopies was the finding negative for FBA). Compared with other centers in our region where rigid bronchoscopy was performed without the preceding flexible procedure, we found that our protocol reduced the rate of negative rigid bronchoscopies. **Conclusions:** Introducing flexible bronchoscopy initially in FBA management reduced the rate of negative rigid bronchoscopies.

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tions; moreover, the rate of these complications increases with delayed diagnosis and treatment [3-7]. Although many comprehensive studies have dealt with the clinical presentation, diagnosis, and outcome of foreign body aspiration, there are no clearly defined clinical and radiological characteristics that can determine the diagnosis. Such uncertainty causes delay in diagnosis and treatment in clinical practice [2,7].

It is widely accepted in many centers that in straightforward cases of foreign body aspiration the diagnosis is based on clinical and physical examination, abnormal radiological findings, and eventual removal of the aspirated foreign body by rigid bronchoscopy [8]. In other cases of suspected foreign body aspiration the management is more complicated, leading to uncertainty regarding the appropriate way to resolve it. Some centers perform flexible bronchoscopies in such cases while other centers use rigid bronchoscopy as an initial procedure. There are no studies comparing the two methods in FBA management. In our region, the rate of bronchoscopies is 11/100,000 children per year [9].

Based on our experience we believe that performing flexible bronchoscopy in children with suspected foreign body aspiration might have a significant impact on the management. To test our hypothesis we performed a retrospective study reviewing our experience in the treatment of pediatric foreign body aspiration for the 5 year period January 2006 to December 2010. The purposes of our study were to define the clinical and radiological features of aspirated foreign bodies, characterize the incidence of FBA in the Israeli-Arab population of the Nazareth area, and evaluate the effect of introducing flexible bronchoscopy as a diagnostic tool prior to performing rigid bronchoscopy.

PATIENTS AND METHODS

We reviewed the electronic files of children who underwent bronchoscopy for suspected FBA between January 2006 and December 2010 in the pediatric department of St. Vincent Hospital, Nazareth. Data collected included patient details (age, gender, location, religious background, history, eyewitness of aspiration event, duration of symptoms, physical examination at admission, radiographic findings), bronchoscopy and FB

Foreign body aspiration (FBA) is common in the pediatric population. It was estimated as 29.9/100,000 population and was responsible for the deaths of 160 children in the United States in 2000 [1]. Many FBA events are preventable. A public health education program can help to reduce up to 35% of the incidences of FBA but cannot eliminate it entirely [2]. Foreign body aspiration leads to significant complica-

details (type of bronchoscopy: rigid/flexible, presence/absence of FB, type and location of FB), and hospital course and complications. All bronchoscopies were performed under general anesthesia in the operating room using intravenous propofol and supplemental oxygen via nasopharyngeal catheter under complete cardiorespiratory continuous monitoring. In nearly all cases, flexible bronchoscopy was initially performed as a diagnostic method, and eventually switched to rigid bronchoscopy in cases of identified foreign bodies for complete extraction. Rigid bronchoscopies were performed immediately by experienced senior otolaryngology surgeons, with the patients under general anesthesia. After the procedure, intravenous propofol and succinylcholine as muscle relaxants were administered without waking the patient. For this purpose, with every bronchoscopy that was performed in our institute for suspected FBA, thorough arrangements were made including reserving the operating room, a senior anesthesiologist, a pediatric pulmonologist, and an otolaryngologist. At our institute flexible bronchoscopy is performed by a pediatric pulmonologist while rigid bronchoscopy is performed by a senior otolaryngologist. For approximately 6 months flexible bronchoscopy was not available at our institute and only rigid bronchoscopies were performed. Additional information includes complications relevant to bronchoscopy or aspiration, such as recurrent bronchoscopies or chronic pulmonary disorders such as recurrent pneumonia with hospitalizations.

Statistical analysis was performed using SPSS statistical software (SPSS Inc., Chicago, IL, USA). The correlation between evidence of foreign body aspiration and clinical data was evaluated by chi-square tests. *P* values < 0.05 were considered statistically significant. Sensitivity and specificity were calculated for symptoms, physical examination, and radiologic findings. A multivariate model with logistic regression comparing clinical data was created, and odds ratios with 95% confidence interval were calculated.

RESULTS

From the 162 medical charts reviewed, 115 children who underwent bronchoscopy for suspected foreign body aspiration were included in the study. Sixty-seven (58.2%) were boys and 48 (41.7%) girls, with a mean age of 33.58 ± 36 months (2.4–180 months); most of them (77, 67%) were 2 years old or younger. Foreign bodies were found in 44 (38.3%) of the children in the study, of whom 28 (63.6%) were boys and 16 (36.4%) were girls. Mean age was 34 ± 32 months (7–168 months) [Figure 1].

Cough was the most common presenting symptom in all the children in the study due to suspected FBA, being reported in 92% of them, followed by history of choking (71%) as the second most common presenting symptom, while acute dyspnea was reported in only 28% [Figure 2]. Among children with FBA, cough was reported in almost all cases (97.7%), choking

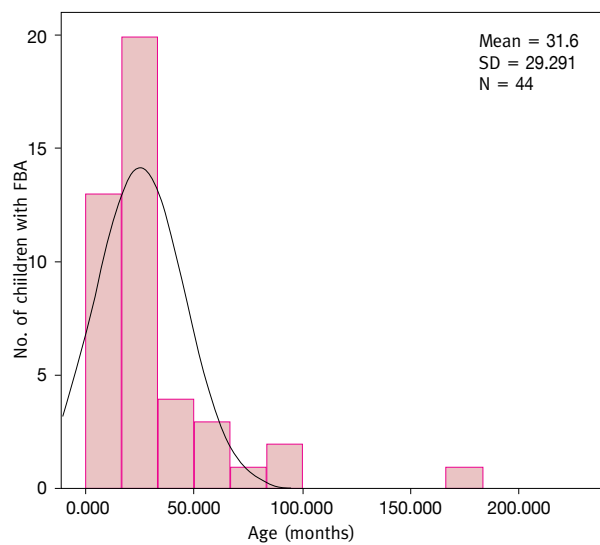
in 59.1%, and acute dyspnea in only 25%. Nevertheless, significant statistical correlation was only found between history of choking and FBA (Pearson chi-square 5.196, *P* = 0.02). The mean duration of symptoms in the children with FBA before presenting to the emergency room was 4.9 ± 10 days (0–60 days). Eighteen children (15.6%) presented to the hospital more than one week after the onset of symptoms. No significant statistical correlation was found between FBA and duration of symptoms at all ages.

Abnormal physical examination findings were found in 73% of the children with FBA, but were also abnormal in 50% of children without FBA [Figure 2B]. Abnormal physical examination in children with FBA included decreased breath sounds (52%), wheezing (43%) and rhonchi (27%). The sensitivity and specificity of physical examination were 72.7% and 48.6%, respectively (*P* = 0.03). There was a statistically significant correlation between physical examination and FBA (Pearson chi-square 5.09, *P* = 0.031).

The chest X-ray findings were abnormal in only 54.5% of children with FBA and were also reported to be abnormal in 15.5% of children without FBA [Figure 2C]. The sensitivity and specificity of chest X-ray findings were 54.5% and 84.5%, respectively. The most frequent chest X-ray finding was air trapping. A significant statistical correlation (*P* < 0.05) was found between abnormal plain chest X-ray and FBA (Pearson chi-square 19.57, *P* < 0.001).

Most of the foreign bodies aspirated in our children were of organic type (70.5%), 22.7% were of non-organic type, and the type of the other foreign bodies was not determined. Peanut aspiration (33%) was most commonly seen in the first group, and plastic toys (40%) in the second group. Foreign bodies were lodged equally in both sides of the bronchial tree (40.9%

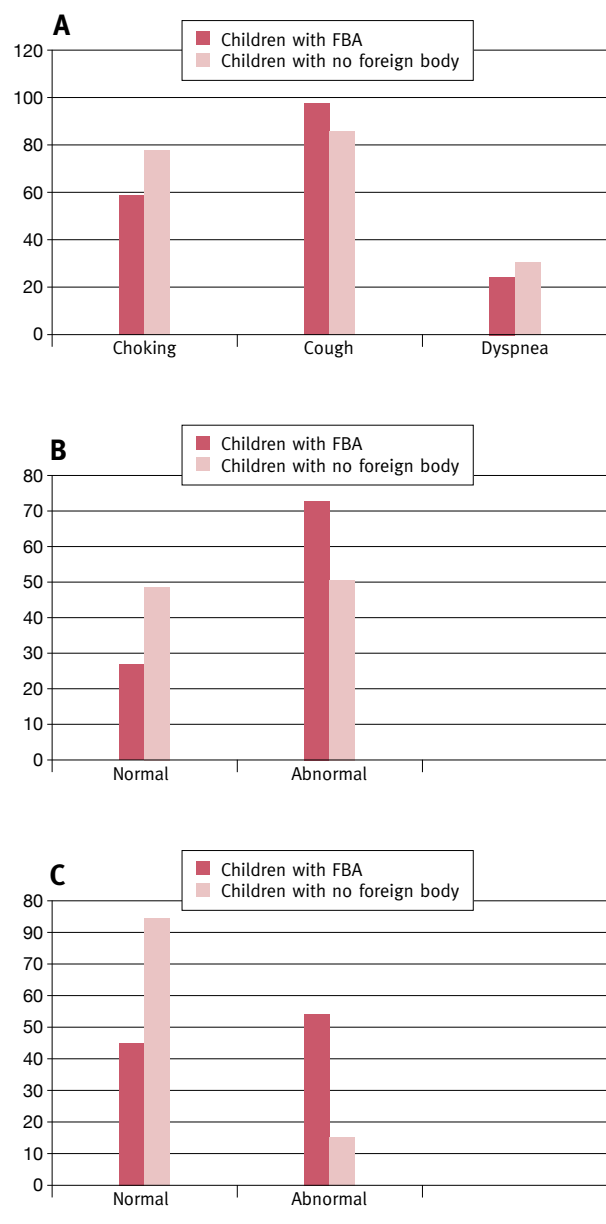
Figure 1. Age distribution of children with FBA



in each side). The remaining foreign bodies were located at the trachea (10.8%) and 7.4% in the subglottic area.

All children were hospitalized according to our local protocol and most bronchoscopies were performed within 24 hours of admission. In most cases flexible bronchoscopy was initially performed, followed immediately by rigid bronchoscopy in cases of FBA for complete removal of foreign bodies. Fifty-two rigid bronchoscopies were performed during the study period and only in 8 cases was the procedure negative, which means

Figure 2. Symptoms [A], physical examination [B], and chest X-ray [C] of children with FBA compared to children with no foreign body

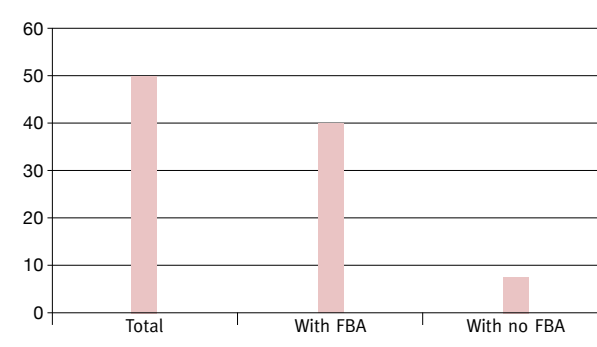


that 85% of the rigid bronchoscopies were indeed required [Figure 3]. The yield of performing rigid bronchoscopy as a sole procedure in managing foreign body aspiration was 59.1% (13 of 22 children had FBA). Both procedures (flexible and rigid) were performed in 28 children with foreign body aspiration and in all cases foreign bodies were successfully extracted by the rigid procedure. There were no major complications such as death, neurologic injury, or pneumothorax after bronchoscopy. One case of pneumomediastinum with spontaneous absorption was reported. The mean period from admission to ED until discharge for all 115 children was 1.7 days. Of the 44 children with FBA, 8 (18%) had post-procedure clinical complications (pneumonia, fever, cough, granulation tissue, pleural effusion, subcutaneous emphysema); 5 (11.3%) underwent repeated bronchoscopy due to unsuccessful or incomplete removal of the aspirated foreign body or to persistent pulmonary symptoms. Most of these complications occurred in children under the age of 2 years compared to older children: 9 (69.2%) and 4 children (30.7%), respectively.

DISCUSSION

In the present retrospective study we analyzed the data of children suspected of having foreign body aspiration who were admitted to our hospital during the 5 year period from January 2006 to December 2010. Our data have shown that FBAs were found in 38.2% of the children with suspected FBA. However, this number is not different to that reported in other retrospective studies. The percent of children with FBA who underwent bronchoscopy is variable and ranged from 25% to 90% [10,11], while in two prospective studies from Israel it was shown that FBA was found in 57% and 43% of the children who underwent bronchoscopy due to suspected foreign body aspiration [10,12]. The percent of positive findings in bronchoscopy at our center was in the lower range due to the easy access and availability of flexible bronchoscopy since this procedure was performed in 91 children, about 79% of all the children with suspected foreign body aspiration.

Figure 3. Rigid bronchoscopy and foreign body aspiration



In our study FBA occurred more in boys (63.6%) than in girls (36.4%), consistent with previous reports [13]. Most children with FBA (89%) were under 5 years old, 64% were under 2 years, and 20% of children with FBA were between 2 and 3 years old, very similar to what has been reported in previous studies.

In the present study cough was present in almost all the children with FBA (98%) with very high sensitivity (97.7%) and poor specificity (11.4%). Choking was reported in 59.1% of children with FBA, but with poor sensitivity and specificity (59.1% and 21.1%, respectively). Acute dyspnea, reported to be as low as 25% of children with FBA, had very low sensitivity (25%) with moderate specificity of 70.4%. Other previous studies reported cough and dyspnea as one complaint and reached a sensitivity of 96–97% and specificity of 63–76% [7,14,15]. In a prospective study from Israel the sensitivity (91.1%) was similar to these studies and to our study, whereas the specificity (42%) was lower than reported in these studies but was still higher than ours [10]. Taken together, our data support the previous belief that medical history plays a key role in the diagnosis of FBA.

Abnormal physical examination was reported in 73% of the children with FBA with moderate sensitivity of 72.7% and poor specificity of 48.6%, as has been similarly reported in previous studies [10,16]. Importantly, we found a significant correlation between abnormal physical findings and FBA. Although physical examination is physician dependent, this positive finding should be taken into consideration when managing children with suspected FBA. Nevertheless, our findings show that in almost half the children with FBA, chest X-ray was reported as normal. The sensitivity and specificity of chest X-ray were 54.5% and 84.5%, respectively. Normal chest X-ray reported in other retrospective studies in children with FBA was about 16% to 40%. In a prospective study by Even et al. [10], 32.1% of children with FBA had normal chest X-ray; in another recent prospective study the level of children with FBA and normal chest X-ray was reported to be as low as 26% [12]. In another recent study, 41% of children with foreign body aspiration had normal chest radiography [17]. Compared to other studies our data have shown a higher percent of normal chest X-ray in children with FBA. The reason might be that our study was retrospective and the chest X-rays in our study were interpreted by more than one senior radiologist.

Our data show that the percent of positive rigid bronchoscopies is very high; however, more important is the finding that only 15% of rigid bronchoscopies were negative. This number would have been much lower had flexible bronchoscopy been available during the whole study period; it was available for a few months of the study. In a recent study the rigid bronchoscopy-negative rate was reported to be as high as 25%; moreover, the authors of the same paper reviewed the literature regarding the negative rigid bronchoscopy rate showing a wide range of 16% to 57% [18]. This finding is clinically significant since rigid compared to flexible bronchoscopy is a more complicated pro-

cedure, time consuming, less convenient for both the physician and the patient, and associated with a higher rate of complications [5,19,20]. Based on our data we recommend using flexible bronchoscopy as an initial diagnostic workup and in cases of FBA switching to rigid bronchoscopy for ultimate foreign body extraction. In addition, in most cases where the diagnosis of foreign body aspiration is doubtful we recommend that both procedures be performed in the same setting. In the event that a foreign body is identified by flexible bronchoscopy, it should be switched immediately to rigid bronchoscopy for complete removal of the foreign body. This protocol is advantageous for the patients, as children with proven FBA will not require two separate procedures and two separate anesthetics, ultimately lowering the risk of repeated anesthesia and procedure [21].

The major limitation of our study is that our data were collected and analyzed retrospectively, which precluded us from controlling the accuracy of the parameters collected such as history taking, physical examination findings, and chest X-ray interpretation.

We conclude from our study that the combination of history, physical examination, and chest X-ray findings are crucial when investigating a child with suspected foreign body aspiration. However, the final diagnosis is made by flexible bronchoscopy, and according to our findings the availability of this procedure significantly reduces the rate of negative rigid bronchoscopies and ultimately saves the child from undergoing an unnecessary procedure.

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