

# Bronchoscopy in children suspected of lower airway aspiration

Sine Holst-Albrechtsen, Søren Kristensen & Knud Larsen

## ABSTRACT

**INTRODUCTION:** Foreign body aspiration (FBA) of the bronchial tree may be a life-threatening condition in children. This retrospective study explores the anamnestic, clinical and objective findings in patients with FBA to the lungs and evaluates the frequency and outcome of the condition in patients in the age group of highest risk.

**METHOD:** Medical files from patients below 18 years of age who had a foreign body removed from the lungs in our hospital were extracted using the procedure code for removal of foreign bodies in the lower airways ("Danish Patient Register") in the period 1990-2013.

**RESULTS:** In the period, a total of 49 children underwent endoscopic foreign body extraction and for 29 of the patients, the files were available for clinical data collection. The median age was 19 months. In nine patients (33%), no symptoms were recorded at admission. Thoracic X-ray was pathologic in 19 (67%) and pulmonary auscultation in 21 patients (73%). Two patients (7%) were in need of post-operative anaesthetic support as a result of respiratory failure, and the over-all complication rate was 28% (eight patients). No fatal outcomes were observed.

**CONCLUSIONS:** The majority of the children in our study were in the 0-3-year age group. A raised suspicion of a foreign body in the lower airways should always trigger bronchoscopy. At admittance, not all patients present with respiratory symptoms. Although no deaths were observed, lower airway foreign body in small children remain a potentially life-threatening condition.

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Foreign body aspiration (FBA) of the lower airway may be associated with a high mortality rate and the diagnosis is a challenging task for the clinician, particularly in children. The symptomatic picture varies widely and, especially among children, the picture varies from no symptoms and objective findings at all to severe respiratory distress [1-11]. The incidence is highest within children in the 0-3-year age group, which constitutes 20% of all children with FBA to the lungs [1-9]. An explanation for this peak may be the lack of muscular coordination in the swallowing process together with a high activity level and distraction in the eating process. The children are missing molars for proper chewing and have imma-

ture neuromuscular mechanisms compared with adults who easily differentiate the chewing and swallowing functions from the respiratory process [7, 8]. The gold standard for diagnosing and treating FBA is rigid bronchoscopy [12].

This retrospective study investigates the anamnestic, clinical and objective findings in children with FBA of the lower airway. Furthermore, the study evaluates how often FBA occurs within children in the age group of highest risk.

## METHODS

This retrospective study is based on information from the patients' medical files. The population was extracted from the "Danish Patients Register" using the codes for bronchoscopy and for endoscopic removal of a foreign body in the lower airways. The observation period is 1 January 1990 – 1 May 2013 (23.3 years; 280 months). Patients below 18 years of age were included. All patients had been treated at the Ear, Nose & Throat (ENT) Department, Hospital of South West Jutland, Denmark. A qualified estimate of the uptake population in the mentioned period for the hospital is 220,000 inhabitants. Bronchoscopy was performed in general anaesthesia using rigid bronchoscope and jet ventilation in all cases and supplemented with video-bronchoscopy when needed (**Figure 1**). The study was approved by the Danish Data Protection Agency. Non-parametric statistics were used.

*Trial registration:* not relevant.

## RESULTS

### Demography and epidemiology

In the period 1 January 1990 – 1 May 2013, bronchoscopy was performed in 49 children below 18 years of age at the ENT Department due to anamnestic suspicion of FBA to the lower airways. Twenty of the patients were girls and 29 boys, with a median age of 19 months (range: 0.7-17 years). A foreign body was found in 29 of the 49 children (59%). The 29 children who had a foreign body extracted counted 11 girls and 18 boys with a median age of 24 months (range: 0.7-17 years). The 20 children (nine girls and 11 boys) in whom no foreign body was observed by bronchoscopy had a median age of 12

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Department of Otorhinolaryngology, Head & Neck Surgery, Hospital of South West Jutland, Esbjerg, Denmark

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 FIGURE 1

Illustration of bronchoscopy with jet ventilation of a child with a foreign body in the lower airways.



months (range: 0.8-7 years). The hit rate for a foreign body showed no difference between the age classes under and over three years of age.

A background population was evaluated for comparison with our study population. During the same observation period, 85 children with a median age of 24 months (range: 0.1-9 years) underwent bronchoscopy at the ENT Department for other reasons than suspected FBA of the lower airway.

In the age group 0-9 years, the estimated incidence of bronchoscopy performed due to suspected FBA of the lower airway in the observation period was 1.8/25,000 children/year, based on a judged uptake of the population for the hospital and information from Statistics Denmark regarding mean age class distribution in the observation period.

#### Clinical observations

Data were insufficient in two patients. Patient characteristics, symptoms, preoperatively findings and perioperatively parameters for the remaining 27 patients in the study population are shown in **Table 1** and **Table 2**, respectively.

In total, eight patients had a pathologic chest X-rays with radiologic descriptions of atelectasis, bronchial ectasia, pneumonic infiltrate or visualization of a foreign body. Chest X-rays were not routinely performed on the suspicion of FBA to the lungs. Auscultative abnormalities were noticed in 16 patients (59%), mainly reduced respiratory sound, but murmurs like rhonchi, wheezing or crepitation were described. Nine patients (33%) came to the hospital based on observed FBA only and presented no pre- or in-hospital symptoms. Interestingly, six of these asymptomatic patients revealed a pathological chest X-ray and/or pulmonary auscultation.

The time window from suspected or observed FBA to the lower airway to admission was more than 24 hours in five patients. In almost every patient, the bronchoscopy took place within the first 24 hours from admission, but bronchoscopy was performed after nearly 48 hours in one young child due to initial suspicion of pneumonia. Another patient had bronchoscopy performed twice within a time span of nine days. The patient had no symptoms initially and the first bronchoscopy after arriving to the hospital was without visualization of a foreign body, but when debuting later with stridor and dyspnoea before the second admission, a nut was located by the second bronchoscopy procedure.

The localizations of the foreign bodies in the airway system are listed in Table 2. The right main bronchus was the most common location, and some foreign bodies were found in multiple pieces in the airway system. Children younger than three years of age were most likely to aspirate a foreign body of organic origin. The type of foreign body was organic in 16 cases (59%). The most frequently identified organic foreign bodies were carrots (40%) and nuts (33%), but bread, popcorn, peas, French fries and milk teeth also occurred. The foreign bodies of inorganic origin were found to be needles, small plastic items and, in one case, a screw. After removal of the foreign body by bronchoscopy, 23 patients (85%) were discharged within 24 hours. As a result of post-operative fever or verified pneumonia or atelectasis affecting the well-being, five patients had to stay hospitalized. Antibiotics were administered in eight patients due to fever, findings of pneumonic infiltrates in the chest X-ray or prophylactically as a result of perioperative evaluation. The overall post-operative complication ratio was 28% – mainly fever, pneumonia, bronchial ectasia, minor bleeding or atelectasis; and in two patients (7%), respiratory failure was observed. In one patient a bronchial stricture, which subsequently needed surgical intervention, was disclosed perioperatively. No fatal outcomes were registered.

#### DISCUSSION

In accordance with other studies, we found the highest incidence of suspected FBA of the bronchial tree in the age group 1-3 years [1-3, 5, 6, 10], and a foreign body was found in more than half of these. The slight predominance of boys in the total group became more evident among those who had a foreign body removed. Other studies revealed the same sex distribution [1, 6-8]. With a mean of nearly two patients per year for suspected FBA of the lower airways, the estimated incidence in the present uptake area was very unevenly distributed 0-5 cases annually. During many years, warnings have been given for carrots and nuts to small children, but there generally seems to be no definite decline

in the frequency of children with foreign bodies aspirated to the lower airways.

Overall, the most common localization of the foreign body was the right main bronchus [2, 3, 9, 10]. Interestingly, a study showed a correlation between the age of the child and how peripherally the foreign body was located in the airway [4]. However, our study showed only foreign bodies predominantly located in the two main bronchi.

The cardinal symptoms in the children at the time of their suspected FBA were cyanosis and cough. The primary symptoms in hospital were cough, stridor and dyspnoea. Our study showed that 33% of the patients were without any symptoms at all, and this finding is in line with the results reported from other studies evaluating symptoms of aspirated foreign bodies to the lower airways in children [1, 2, 6, 7, 10]. In cases without symptoms, the history of aspiration was essential for the diagnosis of FBA to the lower airways. Therefore, to establish the diagnosis in these cases, it is always crucial to obtain a detailed history of the child's behaviour prior to admission and to obtain information of any initial coughing or cyanosis, as also described elsewhere. Additionally, the objective evaluation of the children was, indeed, useful especially in the cases without any symptoms, as most of these patients had a pathologic chest X-ray and/or auscultation. Thus, objective investigation played an important role in enhancing the suspicion of the presence of a foreign body. An analysis of clinical symptoms and findings in suspected FBA to the lower airways concluded that the only variable that predicted the presence of a foreign body with statistical significance was a positive radiological finding [3]. However, a normal X-ray did not exclude FBA. When a child is suspected of FBA to the lungs, a bronchoscopy should always be performed to verify the diagnosis and institute a proper and prompt treatment [3, 9, 11, 12]. Others investigating the symptoms and complications of FBA to the airway system in children with more than 14 days of treatment delay demonstrated that nearly 90% of the children had a pathologic chest X-ray [10]. In the present study, four out of five patients admitted more than one day after suspected aspiration had a pathologic X-ray. Moreover, we conclude that X-ray is convenient in cases with an inorganic foreign body that allows for visualization of size and localization, and in cases with no symptoms.

Our study found the majority of foreign bodies in the right main bronchus which is comparable to the findings of most other studies [2, 3, 9, 10], but contrary to that, one study found that the left main bronchus was the most frequent localization for the foreign body [6]. The type of foreign body was most frequently carrots or nuts as shown in other studies in the Nordic region [2, 3, 9]. Others have demonstrated a high rate of nuts and

TABLE 1

Characteristics	Patients, n/N <sub>sub</sub> (%)
<i>Characteristics</i>	
Age, yrs:	
< 3	18 (62)
≥ 3	11 (38)
Gender:	
Boy	18 (62)
Girl	11 (38)
<i>Prehospital</i>	
Aspiration history	23 (85)
Cough	20 (74)
Cyanosis	10 (37)
Dyspnoea	8 (30)
Respiratory collapse	2 (7)
<i>In-hospital</i>	
Cough	12 (44)
Stridor	10 (37)
No symptoms	9 (33)
Dyspnoea	6 (22)
Cyanosis	5 (19)
Fever	3 (11)
Sensation of a foreign body	2 (7)
Prolonged expiration	2 (7)
Bloody expectoration	1 (4)
Petecchia	1 (4)
Vomiting	1 (4)
<i>Objective findings</i>	
Chest X-ray, pathologic	8/12 (67)
Auscultation, pathologic	16/22 (73)

Preoperatively: patient characteristics, anamnestic, clinical and objective findings (N = 27).

TABLE 2

	Patients, n (%)
<i>Bronchoscopy</i>	
≤ 24 h	25 (93)
> 24 h	2 (7)
<i>Localization</i>	
Right main bronchus	16 (59)
Left main bronchus	7 (26)
Trachea	2 (7)
Right superior lobe	1 (4)
Right middle lobe	1 (4)
Right inferior lobe	1 (4)
Larynx	1 (4)
<i>Type</i>	
Organic:	
Carrot	6 (38)
Nut	5 (31)
Other	5 (31)
Subtotal	16 (59)
Inorganic	11 (41)

Perioperatively: the time from admission to bronchoscopy and characteristics of the foreign body (N = 27).

seeds as well, but not the same quantity of patients with aspirated carrots as in our study population. The divergence of these findings may be explained by cultural differences in eating habits. The nature of the remaining foreign bodies described in other studies were compatible with the ones found in the present study [1, 4, 10]. The Danish Health Authority recommended, with reference to former Danish studies, that no unprocessed carrots and nuts should be given to children under the age of three years. Our study supports these recommendations.

The rate of overlooked foreign bodies was 3.5% which is in alignment with previous reports [3]. Acute bronchoscopy has been advocated by others to minimize the risk for developing granulation tissue in the bronchial tree [10]. In our study, the reason why bronchoscopies were performed more than 24 hours after the aspiration of the foreign body were a lack of symptoms initially or no suspicion of FBA on the part of the caregivers. Despite this fact, these patients had no severe complications. However, complications caused by treatment delay have been observed in other studies [1-3, 7, 9]. A meta-analysis of FBA to the lower airways in children showed that early complications were most frequently pneumonia, larynx oedema and cardiopulmonary arrest [1]. Our study had a 28% overall risk of complications and most of these complications were not severe. Post-operative pneumonia, bronchial ectasia and atelectasis were most common and the mortality rate was zero in our study population, contrary to other studies which have reported a rate of mortality of approx. 3% [2-4, 7]. 7% of the children were admitted with a minor to severe grade of respiratory failure needing intervention and respiratory support before and when arriving to the hospital. An American study reported a frequent need for support from anaesthesiologists to stabilize the child before bronchoscopy [4], but also a higher mortality rate in patients who had to be transported between hospitals, and in patients who had to travel long distance to the receiving unit. In our hospital, a paediatric anaesthesiologist is always on duty and available at any time for the handling of these children. Keeping in mind the somewhat restricted material of this study, a nation-wide study may reveal more detailed and exact information. Given that this is a potentially life-threatening respiratory condition, bronchoscopy will still have to be performed in children on suspicion, at any time and promptly to remove the foreign body, as delayed bronchoscopy can be a challenging procedure.

## CONCLUSIONS

Children below three years of age had the highest risk of FBA to the lower airways. The majority of aspirated foreign bodies in our study were carrots and nuts. Many

children were without symptoms or objective findings when admitted. The cardinal symptoms were initially cough and in hospital the most important information was knowledge of an aspiration history. Pulmonary auscultation and chest X-ray could increase the suspicion further, but never exclude a bronchial foreign body. The study revealed only a few severe complications presumably due to our restricted material, and a national study would likely strengthen an evaluation of the possibly life-threatening condition of FBA to the lower airways in children further.

**CORRESPONDENCE:** Sine Holst-Albrechtsen. E-mail: sineha86@gmail.com

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