
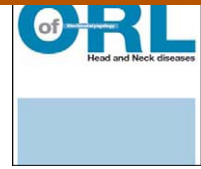




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ORIGINAL ARTICLE

Foreign body inhalation in the pediatric population: Lessons learned from 106 cases

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KEYWORDS

Aspiration;
 Foreign body;
 Rigid bronchoscopy;
 Flexible
 bronchoscopy;
 Diagnostic delay

Summary

Objectives: To review the cases encountered in a tertiary care center so as to assess the incidence of foreign body aspiration in the pediatric population and to draw on our experience to improve prevention and early diagnosis.

Patients and methods: Retrospective study of 106 children under the age of 15 years, admitted to the Hôtel-Dieu de France hospital for flexible and/or rigid bronchoscopy between November 1998 and January 2010, for suspected foreign body aspiration (FBA).

Results: Among the children, 56.6% were aged between one and three years. Peanuts or pistachios were found in 48% of cases. In 73% of cases, the FB was bronchial, and slightly more frequently on the right side (60%); 17.8% of cases presented in emergency immediately after inhalation; 12% presented with life-threatening symptoms; 29% presented within 24 hours and 49% were seen later than 72 hours. In 81% of subjects, a typical penetration syndrome was found on interviewing the parents. Physical pulmonary examination was normal in 21% of patients and chest X-ray in 21.8%. Rigid bronchoscopy was preceded by flexible bronchoscopy in 12% of cases. Parental underestimation of the gravity of the situation was a significant factor in delayed diagnosis. Among the patients, 64% examined 24 hours after inhalation were initially treated for another pathology. Delay in diagnosis and organic vs inorganic FB did not significantly correlate with duration of bronchoscopy. The rate of complications did not significantly increase after a 24-hour diagnostic delay threshold.

Conclusion: FB aspiration is a serious problem. A high index of suspicion is required in health care providers (ENT, pediatricians and family physicians). Physician and especially parental education are the main guarantors of significantly reduced morbidity and mortality in this pathology.

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Introduction

Foreign body aspiration (FBA) remains a significant issue. Worldwide, eight persons die every hour from FBA; most are children [1]. Progress in interventional techniques has improved prognosis in diagnosed FBA [2]. The penetration

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syndrome, however, may be overlooked by parents, and is often followed by an asymptomatic phase which delays diagnosis. Delay in diagnosis, and hence in treatment, may have serious consequences; the index of suspicion should be high.

The present study analyzed our experience in the Hôtel-Dieu de France tertiary care center over the last 12 years. The aim was to identify the spectrum of clinical and radiological manifestations of FBA, to determine the causes of diagnostic delay and thereby improve management. Results were compared with those of a study performed in our center in 1997, to study the evolution of FBA in the Lebanese population [1,3].

Patients and methods

A retrospective study included 106 files of patients aged less than 15 years admitted to the Hôtel-Dieu de France university hospital (Beirut, Lebanon) between 1998 and 2010 for flexible and/or rigid bronchoscopy for suspected FBA.

Data collection

For each of the 106 records, 42 parameters, divided into seven sections, were studied:

- demographic data;
- description of foreign body;
- diagnosis: symptoms, clinical signs, radiological signs;
- treatment: bronchoscopy type, date and duration; any difficulties, and their causes;
- intervention: anesthesiological and operator (ENT or pneumologist) factors;
- postoperative course: postoperative chest X-ray and results, FB-related complications, bronchoscopy-related complications, duration of hospital stay, sequelae, antibiotic and corticosteroid regimes, need for control endoscopy;
- parent education - prevention: circumstances of accident, reasons for delay if consultation later than 24 hours.

Statistics

A dedicated data-base was constructed under Microsoft Access 2003®. Qualitative variables were analyzed by χ^2 test and χ^2 test for trend, Kruskal-Wallis test for non-parametric multiple comparison, Fisher exact test for small-sample comparison, and Student *t* test for quantitative variables. All tests were two-tailed. The significance threshold was set at $p < 0.05$. Analysis used Epi Info™, Version 3.3.2, software.

Results

Thirty-eight of the 106 patients admitted for suspected FBA were girls, and 68 boys: sex-ratio, 1.8. Patients were divided into three age groups: 56.6% were in the one to three-years group; 22.6% of bronchoscopies were negative; 73% of FB locations were bronchial, with 60% right-side incidence; six were tracheal and three subglottic.

Fig. 1 shows time to admission in the Emergency Department. 17.8% of patients presented with superacute

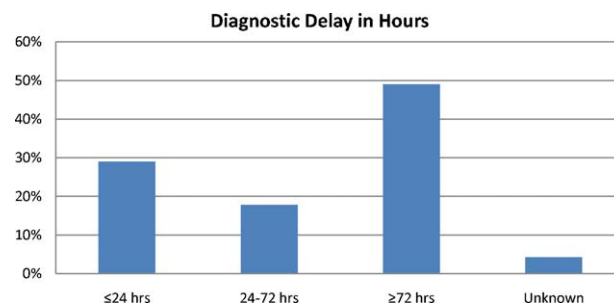


Figure 1 Diagnostic delay after presumed aspiration syndrome.

penetration syndrome. Penetration syndrome was identified on parent interview in 81% of cases. Table 1 shows presenting symptoms and clinical signs.

Chest X-ray was normal in 21.8% of cases, showed ipsilateral obstructive emphysema in 46%, and ipsilateral atelectasia with or without compensatory contralateral hyperinflation in 13.3%. Five of the retrieved FBs were radio-opaque (two pins, one needle, one thumbtack, and one apricot stone).

Among the children, 23.5% showed an aspect of lower airway infection, 56% of which were within seven days of the presumed aspiration.

All patients admitted with suspected FBA underwent rigid bronchoscopy under spontaneous ventilation, performed by pediatric airway specialists (ENT or pneumology); 15% required switchover to assisted ventilation due to perioperative complications such as bradycardia or desaturation.

One 3-year-old who presented two hours after inhaling a snail developed non-lesional edema requiring four days' mechanical ventilation, leading to sequela-free recovery. Otherwise, there were no major postoperative complications except for eight cases of spontaneously resolving subglottic edema due to difficult and prolonged intervention (multiple FB fragments). In 12% of cases, rigid bronchoscopy was preceded by flexible bronchoscopy, due to low initial suspicion. Thirteen of the negative rigid bronchoscopies had been preceded by flexible bronchoscopy; in five of these, no FB had actually been found but uncertainty remained in view of secretion.

Intervention was judged to be difficult in 39.5% of cases; granuloma was implicated in 64% of these. 58% of patients received postoperative antibiotic or corticosteroid treatment, continued after discharge home. 85% of patients had same-day discharge.

Control chest X-ray followed bronchoscopy in 86% of patients; 84% showed no further radiological signs such as pneumothorax or pneumomediastinum, 13% showed signs such as pulmonary or peribronchial edema.

Cases in which significant inflammation was observed perioperatively were re-examined by flexible bronchoscopy at three weeks to rule out bronchial stenosis.

Two main reasons for more than 24-hours' delay in diagnosis were found:

- misdiagnosis: 64% of patients seen more than 24 hours after aspiration were initially treated according to another diagnosis. In most such cases, penetration syn-

Table 1 Symptoms and clinical signs in foreign body aspiration.

Symptoms and clinical signs	Number of cases	Percentage
Stridor	10	9.5
Persistent resistant cough	54	51
Paroxysmal cough	33	31
Productive cough	13	12
Barking cough	8	8
New-onset wheezing	13	24.50
Recurrent and/or persistent respiratory infections	25	23.5
Dysphonia	1	0.9
Hypersialorrhea	4	3.7
Food choking	1	0.9
Severity criteria (mottling, pallor, cyanosis, perspiration, consciousness disorder)	13	12
Retractions (suprasternal, intercostal or subxiphoid)	13	12
Pulmonary Auscultation		
Normal	22	21
Reduced vesicular murmur	40	37.7
Wheezing Rales	39	36.7
Rhonchi	18	17

drome was found on detailed clinical history taking;

- parental oversight/ignorance: in 34% of cases, the child was asymptomatic; either there was no obvious aspiration syndrome, the parents ceased to consider the problem as serious once the child became free of symptoms even after a typical penetration syndrome;
- in two cases, the parents consulted elsewhere within 24 hours of aspiration; rigid bronchoscopy had been performed but failed to remove the FB(s) entirely.

The relation between diagnostic delay was greater than 24 hours and rate of complications was non-significant on Fisher's exact test ($p=0.41$).

Nor did diagnostic delay seem to impact difficulty of FB extraction (Student t test, $p=0.3$). Likewise, organic-type FBs did not correlate with greater difficulty in rigid bronchoscopy (χ^2 , $p=0.94$). There was no significant relation between type of insurance coverage (none, national health insurance, private insurance) and diagnostic delay (Kruskal-Wallis, $p=0.26$). There was, on the other hand, a significant correlation between presence of radiological signs and diagnostic delay superior to 24 hours: χ^2 test for trends, $p=0.006$. The correlation between normal preoperative chest X-ray and negative bronchoscopy was non-significant: χ^2 , $p=0.096$.

Discussion

In the period since Gerbaka et al.'s 1997 study [3], the incidence of all types of FB (water-melon seeds, pistachios, chick-peas, etc.), with the exception of peanuts, has diminished; this is probably thanks to public prevention information campaigns run by the Ministry of Health and to enhanced awareness in pediatricians since the 1997 report. The incidence of peanuts as FBs, however, has remained unchanged. In Lebanon, the diet is starchy; peanuts are served as a snack with almost all family meals and children can help themselves to them at any time; adults will some-

times break them up for children "for safety's sake". It is noteworthy that, despite the demographically large Muslim community in Lebanon, the rate of aspiration of the needles and pins used with head-coverings was very low (three cases).

In all series, FBs are generally foodstuffs and the child is eating and playing at the same time when the accident happens [2,4]. The fact that 56.6% of victims are in the one to three-year-old bracket is explained by their learning to walk and their tendency to put objects in their mouth [2].

The present 1.8 sex-ratio in favor of males is again in agreement with the literature. Under-3-year-olds are most often involved, and FB location is usually bronchial. Is it their higher activity level that puts boys at greater risk, or is it rather a difference in pharyngo-laryngeal junction maturity [4]?

In the present series, diagnosis was straightforward in 17.8% of cases: the child presented with an obvious penetration syndrome. The equivalent figure for Gerbaka et al. was 15% [3]. Diagnosis becomes difficult when the penetration syndrome is overlooked or has resolved spontaneously. In our experience, obvious penetration syndrome on history taking, persistent resistant cough and recent rale were the reasons for consultation most frequently associated with a diagnosis of FBA. Along with reduced vesicular murmur, these are the three factors with the highest positive predictive value. FBA should also figure as a differential diagnosis in atypical presentations, especially of recurrent ipsilateral lower airway infection. Chest X-ray sensitivity was 85% in the present series, while specificity was about 45%. It is of interest only when positive and cannot be used to rule out a diagnosis of FBA as it is often normal when performed early and when the FB is partially obstructive, causing a so-called "bypass-valve" effect [1,5-9]. Chest X-ray is thus mainly indicated to explore for obstructive emphysema, which in the present series was the most frequent sign of a "check-valve" effect, in which air is aspirated but not expired [1,10]. The "ball-valve" effect or Holzknack-Jacobsen phenomenon, in which the foreign body is dislodged during

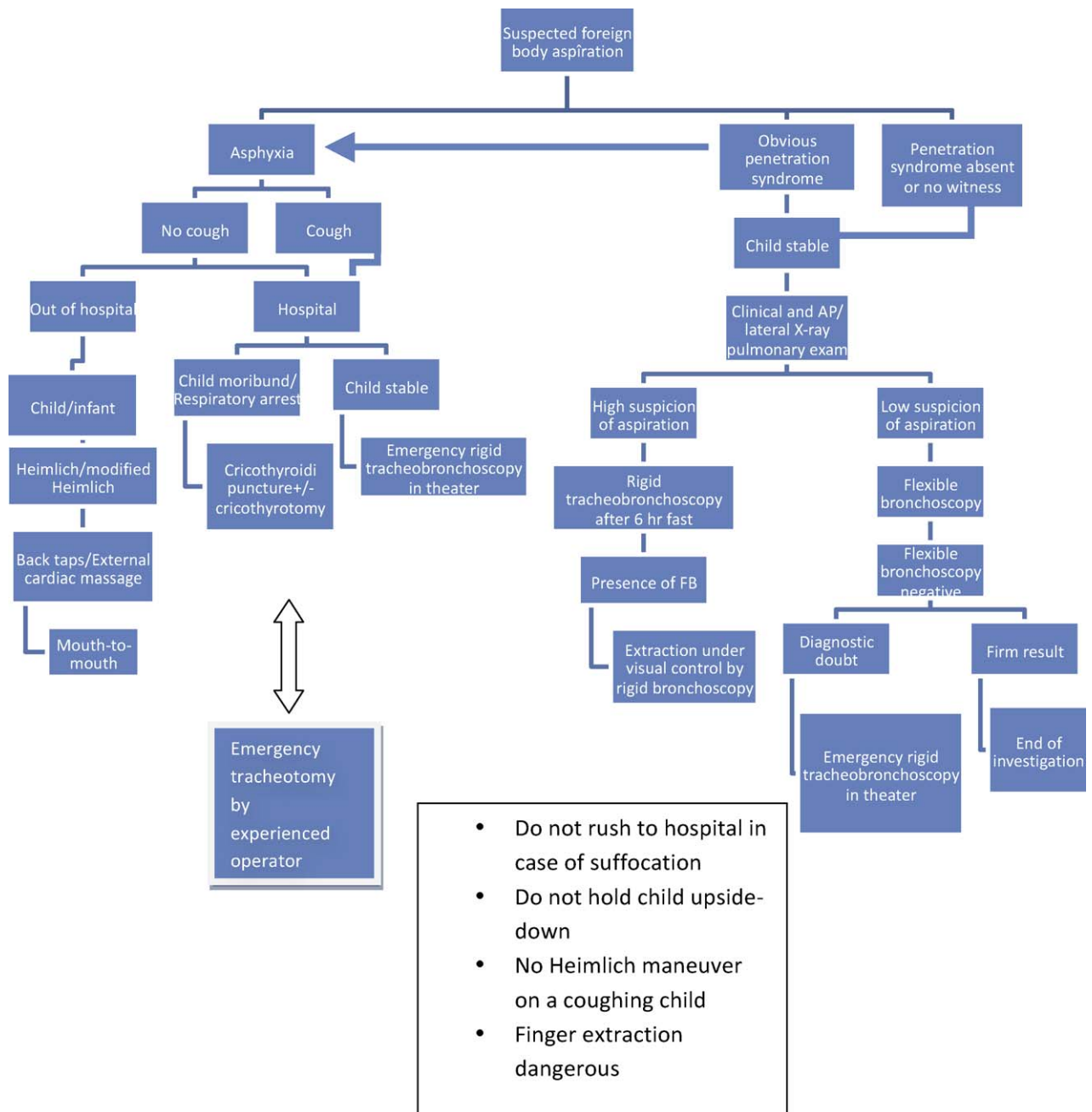


Figure 2 Decision tree for suspected foreign body aspiration.

the out-breath and impacted during the in-breath, induces mediastinal deviation, as found in 14% of the present series (compared to 15% for Gerbaka et al. [1]). Finally, the “stop-valve” effect induces the atelectasias found in 13.3% of the present series, notably in case of organic FBs containing oil that irritates the mucosa, contributing to the formation of granulation tissue which arrests both respiratory phases [1]. To enhance chest X-ray sensitivity, both in- and out-breath views should be taken; where this is not possible, radiography should be performed in lateral decubitus [1,11–13].

High clinical and radiological suspicion is an indication for rigid bronchoscopy [14,15]. In 12% of the present

series, flexible bronchoscopy was performed first; in 50% of these cases, it was part of an exploratory check-up for chronic cough or iterative infection, and the FB was detected serendipitously. In the other cases, it was performed under low suspicion of FBA. FB visualization may be difficult on flexible bronchoscopy if there is a lot of secretion. When absence of FB could not be confirmed (50% of cases), we performed rigid bronchoscopy; where suspicion is low, however, certain authors recommend diagnostic flexible bronchoscopy [16,17]. We have no experience of using flexible bronchoscopy for FB extraction; although described elsewhere, our team considers it to be dangerous [18–22].

Rigid bronchoscopy remains the attitude of choice, and should be performed under general anesthesia and spontaneous ventilation by an experienced operator and an appropriately trained team. Our team uses a Storz bronchoscope, extracting most foreign bodies under video monitoring (Hopkins rod-lens); this provides better control, even though the magnifying lens requires a smaller caliber bronchoscope which may interfere with ventilation.

In some series, more than 24-hours' delay in diagnosis and treatment correlated with higher per and postoperative complications rates and with greater difficulty in FB extraction; in others, this threshold was later, at around seven days [4]. Gerbaka et al. [1] reported an 11% complications rate for three days' delay. In the present series, the 24-hour threshold did not seem to impact complications significantly. We did not examine other thresholds; but granuloma was clearly associated with more than 24-hours' diagnostic delay, and was present in 64% of interventions judged as difficult. Organic FBs did not appear to be associated with more difficult extraction; bronchoscopy procedure and postoperative evolution must, therefore, be affected by other factors, notably local team experience and coordination between team members. Early diagnosis, however, remains important. The present study failed to determine the threshold as of which diagnostic delay begins to affect prognosis; according to the literature, however, this must lie between one and seven days. It is noteworthy that, in Zaytoun et al.'s series [23] of 504 patients aged between three months and 49 years over a ten-year period, previous attempts at bronchoscopic extraction, type of foreign body and bronchoscopy duration emerged as significantly correlated with complications rate, while age, sex and diagnostic delay did not [23].

To explore the causes of diagnostic delay, we first looked at the relation with type of insurance cover. Socioeconomic status was previously shown to be relevant in this regard [1,24]. Gerbaka et al. [1] found that 67% of their child patients were from rural (i.e., disadvantaged) areas; in Lebanon, type of insurance is a reflection of socioeconomic status. Nevertheless, we found no significant correlation between diagnostic delay and type of insurance. This may have been due to the small size of the series, but also to the presence of other, more influential, factors. Thus, parents who are not vigilant or aware of the risks entailed by late diagnosis will often fail to consult: this was the reason for 34% of late diagnoses in the present series. In 64% of cases, delay was caused by initially mistaken diagnosis made by a physician insufficiently alert to the problem, followed by unadapted treatment, with a misdiagnosis rate three times as high as reported in the literature [1,18,25]. Finally, in 2% of cases (two children), patients had been seen elsewhere and attempted extraction under rigid bronchoscopy had failed. The same problems were previously spotlighted by Gerbaka et al. [1], 12 years before the present study. This highlights the importance of parental education with respect to early diagnosis, severity and the need to consult in case of penetration syndrome. Awareness of the importance of early diagnosis on the part of pediatricians, family doctors, ENT specialists and all other health professionals is crucial [26,27].

Physician and above all parental education is the best guarantor of significant reduction in the morbidity and mortality associated with this pathology.

We repeat the recommendations made by our colleagues in 1997, and update the decision tree they drew up in case of accident (Fig. 2).

- starchy food, dried fruit and seeds are forbidden until the age of four years, and chewing gum until three years; diet before one year of age should be smooth, and not taken in prone position without supervision;
- fruit should be peeled, with pips and stones removed;
- toys should be suitable for age.

In case of accident:

- nasal FBs should not be pushed;
- pharyngeal FBs should not be extracted by finger;
- the child should not be held upside-down;
- no maneuver should be performed on a child who is coughing.

Conclusion

Foreign body aspiration remains a serious problem in the Lebanese population. Despite attempted parental and physician education, the rate of initial misdiagnosis is still unacceptably high. While a 24-hour delay was not enough to increase the complications rate in the present series, it is nevertheless true that complications increase with diagnostic delay. Misdiagnosis at the very least increases morbidity. Repeated recommendations to parents concerning the danger of small objects such as peanuts and pistachios, etc. are the best means to reduce the incidence of this pathology, as parental vigilance can then reduce child exposure to dangerous objects.

Disclosure on interest

The authors declare that they have no conflicts of interest concerning this article.

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