# Foreign body aspiration in children and adolescents: experience of a Brazilian referral center*

## Aspiração de corpo estranho por menores de 15 anos: experiência de um centro de referência do Brasil

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## Abstract

**Objective:** To describe the clinical, radiological and endoscopic characteristics of foreign body aspiration among individuals under the age of 15 treated at a referral center in the city of São Luís, Brazil. **Methods:** This was a descriptive study using data from the medical charts of patients treated for foreign body aspiration at the *Hospital Universitário Materno Infantil* between 1995 and 2005. We investigated 72 confirmed cases of foreign body aspiration, evaluating the place of residence, as well as biological, clinical, radiological and endoscopic variables. We used the chi-square test to identify statistically significant differences in frequency among the variables studied. **Results:** The majority of the patients were from outlying areas (55.6%). The following variables presented the highest frequencies: 0-3 year age bracket (81.9%); male gender (63.9%); evolution > 24 h (66.7%); hypotransparency on chest X-ray (57.7%); foreign body in the right lung (41.2%) or in the larynx (20.5%); organic nature of the foreign body (83.3%); complication in the form of localized inflammation (59.4%); glottal edema as an endoscopic complication (47.6%); and seeds (46.6%), fish bone (28.3%) or plastics (25.5%) as the type of foreign body. There were no deaths. **Conclusions:** Preventive care should be a priority for male children under the age of 3 living in outlying areas. Such children should not be given access to substances that can be aspirated, including certain foodstuffs. Simple and easily accessible radiological tests have been underused, which jeopardizes the quality of the initial treatment.

**Keywords:** Foreign bodies; Inhalation; Bronchoscopy.

## Resumo

**Objetivo:** Descrever as características clínicas, radiológicas e endoscópicas da aspiração de corpo estranho por menores de 15 anos em um centro de referência em São Luís, MA. **Métodos:** Estudo descritivo realizado a partir de dados de prontuários dos pacientes atendidos no Hospital Universitário Materno Infantil devido à aspiração de corpo estranho entre 1995 e 2005. Avaliamos 72 casos confirmados de aspiração de corpo estranho em relação à procedência, variáveis biológicas, clínico-radiológicas e endoscópicas. Para verificar se as frequências observadas das variáveis em estudo foram estatisticamente significantes, utilizamos o teste do qui-quadrado. **Resultados:** A maioria do pacientes era procedente das cidades do interior (55,6%). As maiores frequências das diferentes variáveis estudadas foram as seguintes: faixa etária de 0-3 anos (81,9%); sexo masculino (63,9%); tempo de evolução > 24 h (66,7%); hipotransparência na radiografia de tórax (57,7%); localização do corpo estranho no pulmão direito (41,2%) ou na laringe (20.5%); natureza orgânica do corpo estranho (83,3%); complicação como processo inflamatório localizado (59,4%); edema de glote como complicação do exame endoscópico (47,6%); e sementes (46,6%), espinha de peixe (28,3%) e plásticos (25,5%) como tipos mais frequentes de corpos estranhos aspirados. Não houve óbitos. **Conclusões:** Cuidados preventivos devem priorizar crianças menores de três anos de idade, do sexo masculino, provenientes de cidades do interior. O acesso dessas crianças às substâncias com risco potencial para aspiração, incluindo os alimentos, deve ser evitado. Exames radiológicos simples e de fácil acesso à população são subutilizados, o que compromete a qualidade do primeiro atendimento.

**Descritores:** Corpos estranhos; Inalação; Broncoscopia.

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* Study carried out under the auspices of the Maternal and Infant Health Masters Program, Federal University of Maranhão, São Luís, Brazil.

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Financial support: None.
Submitted: 20 August 2008. Accepted, after review: 9 January 2009.

## Introduction

Despite the great advances in diagnostic resources, airway management and endoscopic technology, foreign body aspiration (FBA) continues to cause significant morbidity and is a leading cause of death in the pediatric population.[1,2] Occurring principally in the three first months of life, FBA is influenced by socioeconomic, cultural and educational factors, which determine the frequency and particularities of the foreign body aspirated.[3-6]

The most common complications include inflammation, laryngospasm, chronic bronchitis and pneumonia.[7] Serious complications, such as severe airway obstruction and death, tend to occur in young children due to the small caliber of their airways.[2]

In the United States, FBA is the leading cause of accidental death in children under the age of six, and its annual incidence is estimated to be between 500 and 2,000 cases.[1,7] In Brazil, it is the third leading cause of accidental death in the pediatric age bracket, principally in children under four years of age.[1,4]

Among the complementary diagnostic tests, simple chest X-ray remains the initial examination and shows alterations in 50-65% of the cases, specially when the forced inspiratory-expiratory techniques are used.[8] The sensitivity and specificity of this diagnostic method are 67% and 68%, respectively.[9-13] Localized hyperinflation in the affected lung is one of the most frequently observed alterations, being considered the classical abnormality.[7,14]

However, most foreign bodies are radiotransparent, which makes bronchoscopy the procedure of choice for diagnostic confirmation and foreign body removal, especially in inconclusive clinical cases.[7,14,15]

In order to profile the clinical, radiological and endoscopic characteristics of FBA in patients treated at a public referral clinic in the city of São Luís, located in the state of Maranhão, Brazil, a descriptive study was carried out in patients submitted to respiratory endoscopy due to FBA between 1995 and 2005.

## Methods

This was a descriptive study,[16] based on data obtained from the charts of patients in whom a diagnosis of FBA was confirmed through bronchoscopy at the Federal University of Maranhão Maternal and Infant University Hospital, in the city of São Luís, between 1995 and 2005.

Initially, the hospital registries for the 1995-2005 period were reviewed, and 330 cases submitted to respiratory endoscopy were identified. The inclusion criteria were confirmation of the presence of foreign body through bronchoscopic examination and availability of the medical chart. Patients in whom FBA had been confirmed through surgery were excluded, as were those in whom the foreign body had been spontaneously eliminated and those in whom the foreign body had been located in the nasal region.

Based on the above criteria, 258 cases were excluded. Therefore, the study sample consisted of 72 cases.

### *Procedures and study variables*

A data collection form was filled out for each patient. The form employed was adapted from that devised by Cassol et al.[7] and addressed the following variables:

**Table 1 -** Place of residence, age, gender and time from foreign body aspiration to endoscopy in patients under 15 years of age in São Luís, Brazil, 1995-2005 (n = 72).

| Variable | n | % | p |
|---|---|---|---|
| Initial diagnostic | | | 0.001 |
| FBA | 60 | 83.3 | |
| Pulmonary disease | 10 | 13.8 | |
| FBA and pulmonary disease | 1 | 1.4 | |
| Age | | | 0.001 |
| 0-3 years | 59 | 81.9 | |
| 4-6 years | 6 | 8.3 | |
| 7-11years | 5 | 6.9 | |
| > 11 years | 2 | 2.8 | |
| Gender | | | 0.025 |
| Male | 46 | 63.9 | |
| Female | 26 | 36.1 | |
| Period of evolution | | | 0.001 |
| 0-24 h | 20 | 27.8 | |
| > 24 h | 48 | 66.7 | |
| Unknown | 4 | 5.6 | |
| Place of residence | | | 0.003 |
| Capital | 16 | 22.2 | |
| Outlying city | 40 | 55.6 | |
| Unknown | 16 | 22.2 | |

FBA: foreign body aspiration.

- sociodemographic data (gender, age and place of residence)
- time from FBA to diagnosis (0-24 h; > 24 h)
- initial diagnosis (FBA, pulmonary disease or other)
- signs and symptoms (cough, dyspnea, cyanosis, diffused or localized crackles, stridor, weight loss, moaning, nasal flaring, vomiting, respiratory arrest, dysphagia, secretion with a fetid odor, suffocation, diffuse or localized reduction in breath sounds, localized or diffuse wheezing, "wheeziness", hoarseness, irritability, rhonchi, choking or other)
- radiological findings (hyperinflation, atelectasis, radiopaque foreign body, pneumothorax, pneumomediastinum, deviation of the mediastinal structures, infiltration, decreased bronchovascular markings, consolidation, hypotransparency, deviation of the trachea or normal aspect)
- location of the foreign body (pharynx, larynx, trachea, right lung or left lung)
- nature of the foreign body (organic or inorganic)
- complications and procedures related to the foreign body (localized inflammatory process, laryngeal edema, pulmonary suppuration, pneumothorax, bronchial granuloma, cardiorespiratory arrest, pneumomediastinum, bronchiectasis, bronchitis, bronchial stenosis, laryngospasm, pneumonia, lung abscess, pulmonary hemorrhage, bradycardia, pleural effusion, lobectomy, admission to the intensive care unit, tracheostomy or thoracotomy drainage)
- complications and procedures related to the bronchoscopic examination (laryngeal hemorrhage, desaturation, glottic edema, pneumothorax, laryngospasm with or without desaturation, cardiorespiratory arrest, dislocation of the foreign body to another site, intubation and of the need for more than one bronchoscopic examination)

All radiological records were issued by a radiologist from the hospital under study and were independently reviewed by the authors.

The endoscopic procedures throughout the study were carried out by the same medical staff, which works at the Maternal Infant University Hospital, to which cases from the capital and interior of the state of Maranhão are referred. That staff comprises three pediatric pulmonologists, one of whom was one of the authors of the present study.

All patients suspected of FBA were submitted to endoscopic examination under general anesthesia, and spontaneous breathing was maintained when possible. In addition, patients

**Table 2 -** Radiological study, location and nature of foreign body in patients under 15 years of age in São Luís, Brazil, 1995-2005 (n = 72).

| Variable | n | % | p |
|---|---|---|---|
| Radiological study[a] | | | 0.001 |
| Hyperinflation | 5 | 7.0 | |
| Atelectasis | 3 | 4.2 | |
| Radiopaque FB | 3 | 4.2 | |
| Hypotransparency | 41 | 57.7 | |
| Normal | 18 | 25.3 | |
| Pleural effusion | 1 | 1.4 | |
| Location of foreign body[b] | | | 0.001 |
| Right lung | 28 | 41.2 | |
| Left lung | 9 | 13.3 | |
| Trachea | 10 | 14.7 | |
| Pharynx | 7 | 10.3 | |
| Larynx | 14 | 20.5 | |
| Nature | | | 0.001 |
| Organic | 60 | 83.3 | |
| Inorganic | 12 | 16.7 | |

[a]Missing data in one case. [b]Missing data in 4 cases.

**Table 3 -** Nature and type of foreign body in patients under 15 years of age in São Luís, Brazil, 1995-2005 (n = 72).

| Type of foreign body | n | % |
|---|---|---|
| Organic | 60 | 100 |
| Seed | 28 | 46.6 |
| Fish bone | 17 | 28.3 |
| Grain | 8 | 13.3 |
| Bone (other than fish) | 5 | 8.3 |
| Meat bolus | 2 | 3.3 |
| Inorganic | 12 | 100 |
| Plastic object | 3 | 25.0 |
| Ball inflation needle | 2 | 16.6 |
| Pen cap | 2 | 16.6 |
| Screw | 1 | 8.3 |
| Pendant/medal | 1 | 8.3 |
| Nail | 1 | 8.3 |
| Twig | 1 | 8.3 |
| Chewing gum | 1 | 8.3 |

were monitored continuously through electrocardiography, pulse oximetry and precordial auscultation using a stethoscope. In all such examinations, we used a rigid bronchoscope (model 10338, with Hopkins optics; Karl Storz Instruments, Tuttlingen, Germany) with a caliber compatible with the age of the each patient, together with a cold light source. The foreign bodies were removed using appropriate forceps for each case, according to the type of material aspirated. After foreign body removal, the bronchoscope was reintroduced for the evaluation of the existing bronchial injuries as well as for lavage and aspiration of the secretions retained farther from the site at which the foreign body had been lodged.

In cases in which it was impossible to remove the foreign body using endoscopy, tracheostomy or thoracotomy with bronchotomy was performed. After the procedure, the child remained hospitalized on the pediatric surgery ward for at least 24 h for observation of the clinical evolution as well as for the control radiological study.

The study met the requirements of Brazilian National Health Council Resolution 196/96 and was approved by the Research Ethics Committee of the Federal University of Maranhão University Hospital (Process no. 207/2005).

**Table 4 -** Complications related to the foreign body (n = 37) and to endoscopy (n = 21) in patients under 15 years of age in São Luís, Brazil, 1995-2005.

| Type of complication[a] | n | % |
|---|---|---|
| Complications related to the foreign body | 37 | 100 |
| Localized inflammatory process | 22 | 59.4 |
| Laryngeal edema | 7 | 18.9 |
| Pneumonia | 7 | 18.9 |
| Tracheostomy | 2 | 5.4 |
| Lung abscess | 2 | 5.4 |
| Lobectomy | 1 | 2.7 |
| Thoracotomy with drainage | 1 | 2.7 |
| Other[b] | 7 | 18.9 |
| Complications related to endoscopy | 21 | 100 |
| Glottic edema | 10 | 47.6 |
| Laryngospasm with desaturation | 7 | 33.3 |
| Intubation | 4 | 19.0 |
| Desaturation | 3 | 14.3 |
| Migration of the foreign body to another site | 3 | 14.3 |
| Need for more than one bronchoscopic procedure | 3 | 14.3 |
| Laryngeal hemorrhage | 2 | 9.5 |
| Bleeding | 2 | 9.5 |
| Bronchospasm | 2 | 9.5 |

[a]There were cases in which the patient presented more than one complication. [b]Laryngospasm, pleural effusion, need for more than one endoscopic procedure, more than one hospitalization, dehydration and admission to the intensive care unit.

### *Statistical analysis*

Initially, a descriptive analysis of the variables under study was conducted. The chi-square test was used in order to determine whether the observed differences in frequency between the variables under study were statistically significant. The level of significance was set at 5%. Data were processed using the Epi Info program, version 3.3.2, and analyzed using the BioEstat program, version 3.0.

## Results

Patient ages ranged from 7 months to 15 years, which represented the extremes in the database for the study period. The initial diagnosis was FBA in 83.3% of the cases, followed by pulmonary disease (in 13.8%). This difference was statistically significant ($p < 0.001$). As can be seen in Table 1, the following factors were also relevant: age under three years (in 81.9%; $p < 0.001$); male gender (in 63.9%; $p = 0.025$); > 24 h elapsed between the episode of aspiration and the definite diagnosis (in 66.7%; $p < 0.001$); and residence in outlying city (in 55.6%; $p = 0.003$). The signs and symptoms most frequently observed were dyspnea, cough and diffuse crackles (in 77.8%, 61.1% and 43.5%, respectively; data not shown in tables).

The radiological alteration most frequently observed was hypotransparency (in 57.7%; $p < 0.001$), followed by hyperinflation (in 7.0%), atelectasis (in 4.2%) and radiopaque foreign body (in 4.2%). In 25.3% of the cases, chest X-ray findings were normal. Table 2 shows that the most common location of the foreign body was the right lung (in 41.2%; $p < 0.001$), whereas the nature of foreign body was most often organic (in 83.3%; $p < 0.001$).

As shown in Table 3, the types of organic foreign body most frequently identified were seed (in 46.6%), fish bone (in 28.3%), grain (in 13.3%), other bone (in 8.3%) and meat bolus

(3.3%), whereas the types of inorganic foreign body most frequently identified were plastic object (in 25%), ball inflation needle (in 16.6%) and pen cap (in 16.6%).

The principal complications related to the foreign body were localized inflammatory process (in 59.4%), laryngeal edema (in 18.9%) and pneumonia (in 18.9%). The complications related to endoscopy included glottic edema (in 47.6%), laryngospasm with desaturation (in 33.3%) and the need for intubation (19.0%). There were no deaths in our sample (Table 4).

The success rate of endoscopic foreign body removal was 94.5% (68 cases). There were only 4 cases in which it was not possible to remove the foreign body using endoscopy. Of those 4 patients, 2 were submitted to tracheostomy, 1 was submitted to lobectomy and 1 was submitted to thoracotomy with drainage (Table 4).

## Discussion

Most FBA patients were from outlying cities, a finding that differs from those of other studies, in which the majority of the patients resided in the state capitals.[1] This can be explained by the lower level of education observed in the outlying cities of the Brazilian northeast, the cities in the state of Maranhão being exemplary of this situation.[17]

Age under three years was predominant in relation to the other age brackets, which is in accordance with what has previously been observed in Brazil and in other countries.[1,5,7,18,19] This fact is explained by the natural tendency children have to put anything within reach into their mouth, which is a part of their natural development, together with anatomical characteristics inherent to the airways and to the immaturity of the protective cough reflex.[20] Likewise, the predominance of male patients can be explained by the fact that boys are typically more curious and adventurous.[7]

The principal signs and symptoms observed (dyspnea, cough and diffuse crackles) are in accordance with findings in the literature[1,3,18] and can be explained by the long time elapsed between the FBA episode and the endoscopy, such a delay typically being described as responsible for the increase of morbidity and as a risk factor for treatment failure.[1,2]

In general, the radiological alterations seen in the present study are in accordance with those reported in the literature.[2,8,21] However, the low frequency of hyperinflation can be explained by the fact that chest X-ray tests in forced expiration and inspiration in lateral decubitus are not included in the routine of the facilities where treatment was first sought, despite the contributions of those tests in patients with FBA.[7,8] In those facilities, only anteroposterior and lateral chest X-rays were requested.

However, the high frequency of hypotransparency was due to the inclusion of infiltrates, consolidation and reduction of the bronchovascular markings. The frequency of radiopaque foreign bodies is in agreement with data in the literature,[1,10,22,23] as does the frequency of normal X-ray results,[23,24] showing that X-rays might not be as conclusive regarding the diagnosis.[25]

The predominant location of the foreign body was the right lung, as has been observed in other studies.[1,7,11] However, we observed that the percentage of foreign bodies located in the larynx was high when compared with other locations,[1,7,14,26] a difference that has rarely been reported.[17,22] This finding might be specifically related to the aspiration of fish bones, which, due to their perforating characteristic, are frequently lodged in the larynx.

The high frequency at which fruit seeds were aspirated was similar to that reported in the literature.[1,22,26] However, the high frequency of fish bone aspiration is in contrast with that reported in some other studies,[4,7] in which peanut was the principal organic substance aspirated. This discrepancy might be due to the eating habits of the studied population, in which fish is the basis of the diet and is offered to children beginning in the early years of life. This hypothesis is reinforced by the origin of patients from outlying cities (located along rivers or on the coast), where subsistence fishing is a common practice. Therefore, age under 3 years, fish bone aspiration and location of foreign body in the larynx were found to be interrelated.

The delay in performing the endoscopy occurred due to the failure to make the diagnosis in the city of residence, in general in the countryside. Endoscopy is unavailable in this area, and clinical suspicion is probably delayed, since it depends on whether the physician

involved in the first visit is familiar with the clinical and radiological profile of FBA. Even in developed regions of Brazil, early performance of bronchoscopy is directly related to whether this resource is available at the facility where the first visit takes place, as was reported for the city of Campinas, Brazil, where patients treated at a referral hospital waited an average of 11 h to undergo bronchoscopy, whereas those referred from other cities waited an average of 13 days.[27] However, it has been reported that, even in developed countries, the time from diagnostic suspicion to endoscopy can be as long as one week.[18] However, in the south of Brazil, diagnosis within the first 24 h has been described in most cases.[7,14]

The accuracy of the initial diagnosis in the referral hospital studied here was, partially due to its being a specialized hospital, superior to that typically observed.[7,19] However, the exclusion of cases presenting negative endoscopic results contributed to such accuracy. Nevertheless, it has been reported that the small number of referral centers capable of performing emergency respiratory endoscopies can negatively influence the outcome of cases of bronchial aspiration, with increased complications,[27] which underscores the need to establish more such centers.

We found the principal complications attributed to the presence of foreign bodies to be related to their location (lung, trachea and larynx), nature (predominantly organic) and duration at the site. The localized inflammatory process can be explained by the fact that the predominant locations of the foreign bodies were the lung and trachea, whereas the laryngeal edema could be explained by the aspiration of fish bones and their location in the larynx.[1,2,10,21]

In most cases, there were no complications related to the endoscopic examination.[1,22] The presence of mild glottic edema and small hemorrhages during the examination, typically excluded by other authors,[23,28] were included here. In the present study, there were no cases of hemodynamically significant hemorrhage, nor were there cases of bronchial perforation, pneumomediastinum, pneumothorax or death, as have been reported in some studies.[13,14,24]

Among the contributions provided by this study, we highlight the collection of information about FBA at a location in the Brazilian northeast, with a relatively large sample size as well as the elevated frequency of foreign bodies located in the larynx, which was attributed to the eating habits of the population. One limitation of our study was the fact that some charts were missing data, which impaired the analysis of certain variables.

The results presented here indicate that preventive care should be focused on boys under three years of age, residing in cities located along waterways or on the coast, who are apparently at risk for fish bone aspiration into the larynx. Parents should be instructed on other food-related risks, such as grains and fruit, as well as keeping small potentially inhalable objects out of the reach of children. Chest X-ray in forced inspiration and expiration has been under-utilized in the diagnosis of FBA, despite the contributions it might make. Educating the professionals involved in the initial treatment at public health care facilities is an important step toward reducing FBA-related morbidity, as is developing the capacity to treat patients using respiratory endoscopy. The safety and efficacy of the bronchoscopic examination were underscored by the absence of severe complications or deaths in the present study.

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