Title: Flexible bronchoscopy: first-choice method of removing foreign bodies from the airways of Children

Running Title: Flexible bronchoscopy to aspiration foreign bodies

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INTRODUCTION

The aspiration of foreign bodies into the airway is an important cause of death in children worldwide. Data from 2015 in Brazil shows it as the leading traumatic cause of death and the 10th overall cause of death among children (806 deaths in 2015) (1). In a mortality study with data between 2000 and 2009 in the United States, the national mortality rate for children with a diagnosis of an airway foreign body (AFB) was 2.75% (2).

The incidence is higher in children aged 1-2 years, due to inherent characteristics of development: immature coordination of swallowing, easy distractions, oral exploration and incomplete dentition (3). The presentation and severity depends in the degree of airway obstruction – a total or subtotal obstruction of the proximal airway may lead to a life-threatening asphyxia; while partial or distal airways obstruction produce milder symptoms. Prompt recognition is essential, because delayed diagnosis can lead to a chronic condition (recurrent pneumonias, lung abscess, bronchiectasis, pneumothorax or asthma-like symptoms – cough, wheezing) (3). The radiological findings are usually non-specific or even absent (4), so, in the event of a compatible clinical history, a bronchoscopy evaluation is needed.

After the introduction of rigid bronchoscopy there was a great reduction in mortality due to aspiration of foreign bodies, however flexible bronchoscopy has been shown to be an important method in the evaluation and treatment. In this study, we present our experience using therapeutic flexible bronchoscopy (FB) as the first-choice method to remove foreign bodies from children's airway.

METHODS

In this retrospective study, we included pediatric patients (under 18 years) who underwent bronchoscopy for removal of AFB at the Service of Respiratory Endoscopy of the Heart Institute, Hospital das Clinicas of the School of Medicine of the University of Sao Paulo in the period from January 2014 until June 2020. We reviewed medical and bronchoscopy records. We collected information about the equipment used (flexible or rigid bronchoscope and the ancillary instrument used), foreign body location and nature (organic or inorganic), age, sex, success rate and complications.

All patients were submitted to flexible bronchoscopy to locate the AFB in the tracheobronchial tree, evaluate the degree of inflammation or suppuration of the bronchial mucosa, and choose the equipment that was necessary for therapeutic

measures.

The procedures were performed under sedation or general anesthesia. Topic 1% lidocaine without vasoconstrictor was used as a topic anesthetic of the larynx, trachea, and bronchia, with a maximum dose corresponding to 4.5 mg/kg. During the procedure, all patients were monitored with oximetry, cardiac monitor, and noninvasive arterial pressure measurement.

The following equipment were used: flexible bronchoscopes with an external caliber of 3.2 mm (FB 10X Pentax) and working channel of 1.2 mm in children younger than 10 years and flexible bronchoscopes with an external caliber of 4.9 mm (BF P30 Olympus) and working channel of 2.0 mm when older. Rigid bronchoscopes (Karl Storz GMBH & Co.), with an external diameter of 3.5 or 5.5 mm, telescopic optical system, suspension laryngoscope and the association of methods in specific cases, when flexible bronchoscopy failed.

After the procedure, patients were submitted to a review of the tracheobronchial tree to exclude the presence of other AFB, fragments of the removed AFB or structural alterations. The patients were sent to a recovery room, being monitored and allowed to recover from anesthesia.

The project was submitted to the institutional review board and approval - Brazilian Research database number CAAE 17877919.0.0000.006.

RESULTS

A total of 40 pediatric patients were treated, 22 (55%) were boys. Children under 3 years accounted for 51% of cases with a peak incidence between 1 to 2 years accounting for 35.5% of cases (table 1).

Table 1: Demography

Variable	Patients n (%)
Age (years)	
0 - 1	1 (2,5%)
1 - 2	15 (35,5%)
2 - 3	5 (12,5%)
3 - 4	2 (5%)
4 - 5	2 (5%)
5 - 6	3 (7,5%)
6 - 7	2 (3,5%)
7 - 8	2 (5%)
8 - 9	1 (2,5%)
9 - 15	4 (10%)
15 - 18	3 (7,5%)
Sex	
Male	22 (55%)
Female	18 (45%)

Regarding the location of the AFB, 35% were lodged in the right main bronchus, 30% in the left main bronchus and 17,5% on trachea, and the majority were inorganic (55%) (table 2). The majority of the removals were done by a flexible bronchoscopy (87,5%), under general anesthesia (90%), using a basket (47,5%) or a rat tooth forceps (35%) (table 3).

Table 2: AFB location and nature

Variable	Patients n (%)
Location	
Larynx	3 (7,5%)
Trachea	7 (17,5%)
Right main bronchus	14 (35%)
Left main bronchus	12 (30%)
Intermedium bronchus	3 (7,5%)
Left lower lobe	1 (2,5%)
Nature	
Organic	16 (40%)
Inorganic	22 (55%)
Unknown	2 (5%)

Table 3: Procedure

Variable	Patients n (%)
Anesthesia	
General	36 (90%)
Sedation	4 (10)
Bronchoscopy	
Flexible	35 (87,5%)
Rigid	3 (7,5%)
Flexible + rigid	1 (2,5%)
Laringoscopy	1 (2,5%)
Ancillary material	
Basket	19 (47,5%)
Rat tooth forceps	14 (35%)
Forceps	1 (2,5%)
Rigid forceps	4 (10%)
Unknown	2 (5%)

The overall removal success rate was 100%. In 36 cases (90%) the AFB was re-

moved using a flexible bronchoscope. In 3 cases (7.5%) there was a need for rigid bronchoscopy – in one of these cases an unsuccessful removal with a flexible bronchoscopy were already made on another institution, and in another case there was a subglottic stenosis impeding the passage of the flexible bronchoscopy. In 1 case (2.5%) both methods were used (table 3).

Complications occurred in 3 cases (7.5%). One of them was a minor complication – right main bronchus laceration during the removal. There were 2 cases of major complications: 1 of respiratory failure and 1 of cardiac arrest (both cases need oro-tracheal intubation). No deaths were reported.

DISCUSSION

Before the 20th century, AFB aspiration was associated with a high mortality rate – before bronchoscopy, the only treatment was palliative tracheostomy and the death rate was high as 50%. The first bronchoscopy was performed by Gustav Killian in 1897, to extract an AFB from the trachea (a pig bone). Since then, bronchoscopy is extensively used to the evaluation and treatment of AFB, reducing the mortality rate to less than 1% (5).

The bronchoscopic removal of AFB in children is a complex and demanding procedure with a high potential for complications, such as fragmentation of the aspirated object, migration of the object to the contralateral bronchial tree or displacement to a more central presentation (for instance: trachea), causing marked airflow obstruction. Historically, rigid bronchoscopy has been the gold standard for the treatment of pediatric foreign body inhalation, but several authors have described FB as a diagnostic and therapeutic method for the removal of AFB. (6).

Our results show that, in most cases, flexible bronchoscopy is a safe and effective for the removal of AFB. Several other groups also report good outcomes with FB: Swanson et al (7) in a study of 40 cases – 24 were removed successfully with FB; De Palma et al (8) reviewed 51 cases – 34 successfully removed with FB; Kim et al (9) describes 20 cases of removal with the FB and a retrieval basket; Tang et al (10) had a 91.3% success rate of removal using FB. In our experience, 90% of the AFB were removed through FB, confirming that FB can be used as a diagnostic and therapeutic tool, reducing the need of the rigid bronchoscope.

Rigid bronchoscopy has some advantages – they are larger in diameter, ensuring safe ventilation and gives a better operative vision, being useful in cases of massive bleeding or central airway obstruction by large or sharp foreign bodies, but it requires general anesthesia and it is more invasive (5, 8).

The FB procedure is relatively easier and safer, requiring only sedation and local anesthesia in older children and adolescents, reducing the costs and the need for hospitalization. Another advantage is that it can reach more distal bronchi and can be used in patients with jaw or skull fractures (8).

In rare instances, when bronchoscopy removal fails, surgical intervention (bronchotomy or segmental resection) in demanded (5). In our series, no surgical intervention was needed.

The removal of AFB can lead to several complications: hemoptysis, laryngeal/pulmonary edema, pneumonia, atelectasis, fever, respiratory failure, tracheoesophageal fistula, pneumothorax and might require prolonged hospitalization, intubation and additional procedures (5). We had a small number of major complications (2 cases – 5%), including respiratory failure and cardiac arrest, thus the importance of performing the procedure in a room equipped for resuscitation and mechanical ventilation.

Our study has some limitations: it is single-center, retrospective and with a limited number of individuals. We also didn`t have information about the clinical data upon arrival on the emergency room.

In conclusion, based on our series and results from previous reports, we believe that rigid bronchoscopy is not mandatory in all cases of AFB and that FB can be used as the first therapeutic option. Some factors contribute to the success rate with minimal complications: the experience of the team and the availability of equipment. The knowledge of the different techniques in bronchoscopy minimizes the therapeutic failure by facilitating the removal of unexpected objects, especially in infants.

REFERENCES

1. França EB, Lansky S, Rego MAS, Malta DC, França JS, Teixeira R, et al. Leading causes of child mortality in Brazil, in 1990 and 2015: estimates from the Global Burden of Disease. Rev Bras Epidemiol May 2017; 20 SUPPL 1: 46-60
2. Cheng J, Liu B, Farjat AE, Routh J. National estimations of airway foreign bodies in children in the United States, 2000 to 2009 Clin Otolaryngol. 2019 May ; 44(3): 235–239.
3. Lowe DA, Vasquez R, Maniaci V Foreign Body Aspiration in Children. Clinical Pediatric Emergency Medicine, 16(3), 140–148. (2015).

4. Pasaoglu, I. Dogan R. Demircin M. Hatipoglu A, Boze AY. Bronchoscopic Removal of Foreign Bodies in Children: Retrospective Analysis of 822 Cases. Thorac. Cardiovasc. Surgeon 39 (1991)
5. Rodrigues AJ, Oliveira EQ, Scordamaglio PR, Gregorio MG, Jacomelli M, Figueiredo VR. Flexible bronchoscopy as the first-choice method of removing foreign bodies from the airways of adults. J Bras Pneumol . May-Jun 2012;38(3):315-20. doi: 10.1590/s1806-37132012000300006.
6. Cutrone C, Pedruzzi B, Tava G, Emanuelli E, Barion U, Fischetto D, *et al.* The complimentary role of diagnostic and therapeutic endoscopy in foreign body aspiration in children. Int J Pediatr Otorhinolaryngol 2011;75:1481-5.
7. Swanson KL, Prakash UBS, Midthun DE, Edell ES, Utz JP, McDougall JC, et al. Flexible Bronchoscopic Management of Airway Foreign Bodies in Children. CHEST / 121 / 5 / MAY, 2002
8. De Palma A, Brascia D, Fiorella A, Quercia R, Garofalo G, Genualdo M, et al. Endoscopic removal of tracheobronchial foreign bodies: results on a series of 51 pediatric patients, Pediatric Surgery International. Published online 28/02/2020
9. Kim K, Lee HJ, Yang EA, Kim HS, Chun YH, Yoon JS, *et al*. Foreign body removal by flexible bronchoscopy using retrieval basket in children. Ann Thorac Med 2018;13:82-5.
10. Tang L, Xu Y, Wang Y, Wang C, Zhu G, Bao X. et al. Airway foreign body removal by flexible bronchoscopy: experience with 1027 children during 2000-2008. World J Pediatr, Vol 5 No 3 . August 15, 2009