The efficacy of fiberoptic bronchoscopy through laryngeal mask airway in pediatric foreign body extraction

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Background The use of fiberoptic bronchoscopy (FOB) through laryngeal mask airway (LMA) in children allows the use of an adult-size bronchoscope with its grasping tools; thus, it may aid in foreign body (FB) extraction.

Aim We aimed to evaluate the efficacy of FOB through LMA in pediatric FB extraction.

Patients and methods We prospectively recruited all children (≤16 years) who presented to or were referred to the Department of Pulmonary Medicine, Ain Shams University Hospital, with a clinical suspicion of FB inhalation between June 2012 and June 2013. All the patients were subjected to FOB through LMA under general anesthesia. Rigid bronchoscopy (RB) was available to extract any FB that could not be removed.

Results Of the 49 children suspected to have FBs, 41 FBs were identified in 28 boys and 13 girls, mean age 5.9 years (9 months to 16 years). FBs were more often lodged in the right side than in the left one (48 vs. 38%) and with predominance of organic FBs (75.6%), mainly seeds (60.9%). Successful extraction by the current technique was achieved in 34 of 41 (82.9%) FBs identified. Extraction of six of seven FBs that could not be removed was successful with the use of RB and open thoracotomy was required in one case. Noncritical complications related to FOB through LMA included laryngeal edema, transient hypoxia, gastric distension, mild hemoptysis, and fever, which occurred in five, five, four, three, and two patients, respectively. One critical complication (stridor) occurred that was related to RB.

Conclusion In conclusion, FOB through LMA is safe and effective in pediatric FB retrieval under general anesthesia with RB backup. *Egypt J Broncho* 2014 8:57–63

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Keywords: fiberoptic bronchoscopy; laryngeal mask airway, pediatric foreign body inhalation

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Introduction

Foreign bodies (FBs) aspiration into the tracheobronchial tree is a common problem in children, necessitating prompt recognition and early management. A delay in the diagnosis and retention of FBs usually increases morbidity and mortality, ranging from fatal airway obstruction to recurrent cough or wheezing [1].

Before the 20th century, aspiration of a FB had a 24% mortality rate. With the development of modern bronchoscopy techniques, mortality has decreased markedly [2]. For many years, rigid bronchoscopy (RB) remained the mainstay procedure for FBs extraction because it facilitated control of the airway and ventilation, and because of the availability of different equipment for FBs extraction [3,4].

Fiberoptic bronchoscopy (FOB) has been used for several decades as a diagnostic modality of various respiratory disorders in children [3,5]. However, its use for the extraction of airway FBs in children has been hampered by the small caliber of the suction channel and the lack of ancillary instruments available to grasp the airway FBs [3]. In recent years, several studies have reported the successful removal of FBs with the pediatric FOB [1,4,6].

The laryngeal mask airway (LMA) is used for ventilation and administration of anesthesia in children during FOB [7,8]. Our review of the literature indicated a paucity of published data on the use of FOB through LMA in FBs extraction in children [3,8,9]. The large internal diameter of LMA compared with the endotracheal tube enables the use of larger external diameter FOB with the subsequent use of their FBs extraction ancillary tools [7,8].

We have previously presented our Pulmonary Medicine Department experience with bronchoscopic FB extraction including an initial successful trial of FB extraction using FOB through LMA in only five patients [10]. With accumulated experience, the procedure has gradually become familiar and acceptable. Thus, it seems appropriate to evaluate the efficacy of FOB through LMA in pediatric FB extraction.

Patients and methods

We prospectively recruited all children (≤16 years) who presented to or were referred to the Pulmonary Medicine Department, Ain Shams University Hospital, with a clinical suspicion of FB inhalation during the period between June 2012 and June 2013.

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All the patients were subjected to FOB extraction of airway FBs through LMA performed under general anesthesia. RB was readily available for extraction of any FB that could not be removed by FOB through LMA.

The following data were collected for each case: age, sex, clinical presentations, duration of symptoms before bronchoscopy, radiology findings, the type and location of the FBs, ancillary instruments utilized, the success rate of FB extraction with FOB through LMA, need for RB extraction, and procedure-related complications.

In our practice, the bronchoscopist was assisted by an experienced team of two well-trained registered nurses, a bronchoscopy assistant, and two anesthesiologists. Informed consents were obtained from the patients' parents before the treatment. Approval was obtained from the local institutional board.

FOB through LMA in FB extraction

Choice of LMA and FOB

The size of the LMA was chosen according to the patient's age, whereas the FOB was chosen according to its outer diameter such that it could pass easily into LMA as reported previously by Nussbaum *et al.* [5] and Kim *et al.*[11]. The size of LMA adjusted for appropriate FOB in our unit is shown in Table 1. Figure 1 shows the different views of the LMA while passing the FOB inside it.

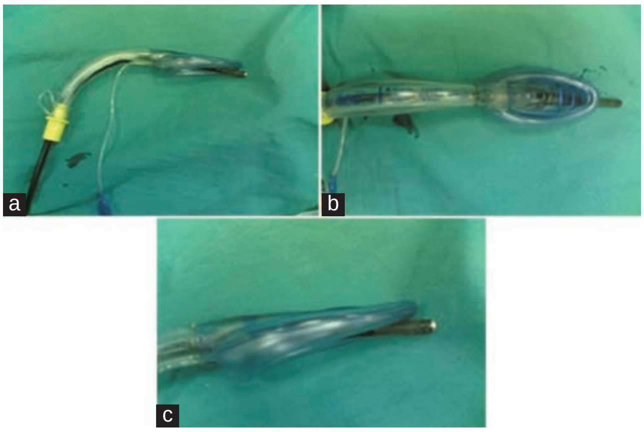
Anesthesia

General anesthesia was administered by the anesthesiologist. Anesthesia was induced by a facemask using inhalation halothane 0.5–3%, followed by insertion of an intravenous cannula and administration of atropine 0.01 mg/kg, followed by insertion of LMA; then, anesthesia was continued with intravenous propofol 3–4 mg/kg. A skeletal muscle relaxant was administered, succinyl choline 0.5 mg/kg, followed by a postsuccinyl dose of atracurim 0.25 mg/kg. Hydrocortisone 1–2 mg/kg was administered to prevent laryngeal and vocal cord edema.

LMA application

Lubricated LMA was inserted orally until it was seated behind the larynx and the glottic opening was sealed by inflation of the cuff. When inserted correctly, the opening of the laryngeal mask is situated just in front of the vocal cords. A feeding tube may be inserted during the procedure to prevent abdominal distension.

Fig. 1



Different views of the laryngeal mask airway (a–c) while passing the fiberoptic bronchoscopy inside it.

Table 1 LMA size adjusted for appropriate fiberoptic bronchoscopy

Weight (kg)	LMA size	Fiberoptic bronchoscopy		
		Model used[a]	Outer diameter (mm)	Inner diameter (mm)
5–10	1.5	FB-15X	4.9	2.2
10–20	2			
20–30	2.5			
30–50	3	FB-1830T3	6	2.6

LMA, laryngeal mask airway; [a]Pentax Instruments; Asahi Optical, Tokyo, Japan.

FB extraction

The FOB was introduced through a bronchoscopy adapter (swivel) connected to LMA after general anesthesia was established. A 2% lidocaine solution, usually between 1 and 2 ml in volume, was selectively applied over the vocal cords through the bronchoscope to prevent laryngospasm. The patients were placed on a bronchoscopy table in a supine position. Bronchoscopic examination was first performed in a standard manner with a careful inspection of the airways until the location of the aspired FB was determined. Appropriate ancillary equipment were advanced carefully through the bronchoscope for FB extraction. The ancillary tools available included grasping forceps with covered tips, alligator-type grasping forceps, standard biopsy forceps, rat-toothed FB forceps, tripod-type forceps, and basket-type forceps. The FB was grasped and pulled out through the LMA and then the FOB, FB, and LMA were pulled out *in toto*. Once the FB was removed, the FOB was reintroduced once more to rule out another FB or residual fragments.

RB was only used to extract FB that could not be removed by FOB through LMA. The procedure was carried out under general anesthesia using a rigid pediatric bronchoscopic system with optical telescopes (Karl Storz Instruments, Tuttlingen, Germany) with variable calibers according to the age of the patient using extracting forceps to remove foreign objects.

Blood pressure, oxygen saturation, ECG, heart rate, tidal volume, and minute ventilation were all monitored continuously and if the patients were hypoxic. Readjustment of the oxygen concentration and the procedure was stopped temporarily when necessary.

Results

During the study period, 49 children underwent FOB because of the suspicion of FB aspiration. A total of 41 FBs were identified in 41 children, mean age 5.9 years (range: 9 months to 16 years); 70.7% (29 patients) of the patients were 7 years or below. The median duration between aspiration history and bronchoscopy in patients with FBs was 2 weeks (12 hours to 2 years). The characteristics of patients with airway FBs in terms of sex, age distribution, and time elapsed between aspiration and bronchoscopy are shown in Table 2.

All patients underwent chest radiograph before the FOB. Chest radiograph was normal in 34.1% of the patients. Different radiologic findings found in patients with airway FBs are shown in Table 3 and Fig. 2.

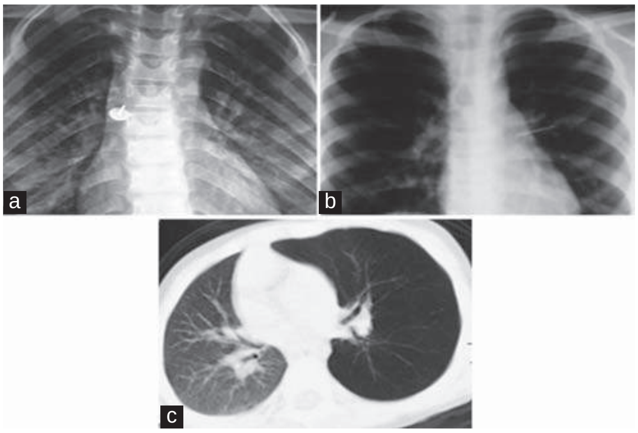
Different types of FBs were removed (Fig. 3). The number of organic FBs removed was 31, in which seeds were the most common (60.9%). Nine inorganic FBs were removed, with scarf pin being the most common (9.7%). The most common location of FBs was the right main bronchus (34.1%), followed by the left lower lobe bronchus (21.9%). Anatomical locations and types of FBs found in patients are presented in Table 4.

FOB through LMA successfully extracted 34 FBs of 41 FBs (82.9%) identified. FBs extraction was achieved uniquely using biopsy forceps, tripod forceps, and alligator-type grasping forceps in nine, eight, and eight cases, respectively (Fig. 4), whereas more than one ancillary instrument was used in nine cases.

Table 2 Characteristics of patients with airway foreign bodies

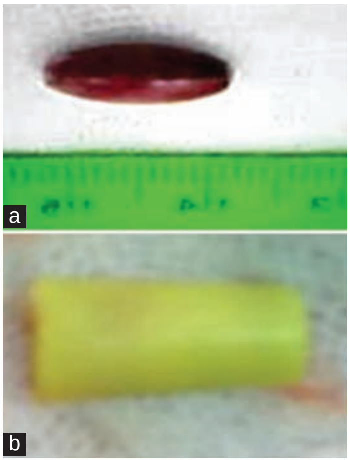
Characteristics	*N*
Sex (male/female)	28/13
Age (years)	
<1	5
1–3	17
4–7	7
>7	12
Duration	
<24 h	7
1 week to <4 weeks	15
1 month to <12 months	15
≥1 year	4

Fig. 2



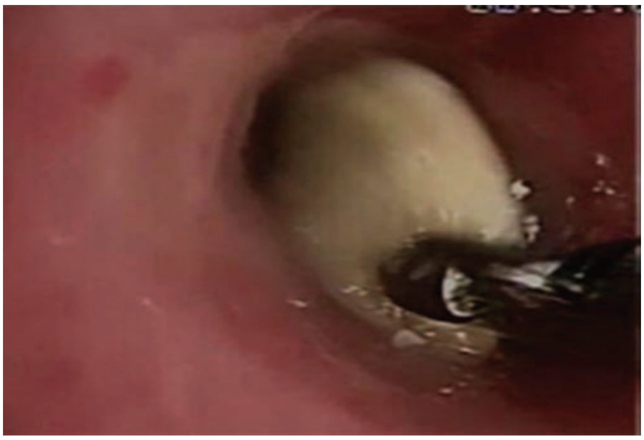
(a) Chest radiograph with a disk pin in the right main bronchus and (b) A scarf pin in the left main bronchus (arrow). (c) Computed tomography scan showing left obstructive emphysema.

Fig. 3



(a) Successful extraction of a rosary bead with fiberoptic bronchoscopy. (b) Extracted plastic object with rigid bronchoscopy after failure with fiberoptic bronchoscopy.

Fig. 4



Fiberoptic bronchoscopic view showing retrieval of a seed after being grasped by the forceps.

Extraction of six of seven FBs that could not be removed by FOB through LMA was successful with the use of RB, all of which had a long duration of FB aspiration. One FB (scarf pin) could not be removed with both FOB and RB after several attempts because of a 4-week duration of FB aspiration and extensive granulation tissue, which precluded FB visualization by bronchoscopy. This patient eventually required a thoracotomy. All FBs were not urgently removed as none of our patients presented with signs of respiratory distress. All FBs removed were extracted at the first attempt and no second intervention was needed to remove FBs.

With the use of the FOB through LMA, the average time of the procedure was 15 min (range: 7–45 min). The average time of the procedure with the RB was 35 min (range: 20–95 min).

Complications encountered during or post-FOB through LMA were minor, non-life-threatening complications (Table 5). Transient postbronchoscopy laryngeal edema was observed in five patients and resolved spontaneously within less than 8 h. Transient hypoxia developed in five patients that was alleviated by readjustment of the oxygen concentration or by temporary cessation of the procedure. Gastric distension occurred in four patients that required nasogastric tube insertion to decompress the stomach in two patients. Mild hemoptysis was reported in three patients and was controlled by the administration of endobronchial cold saline. Transient low-grade fever occurred within 24 h of the procedure (resolved spontaneously) in two patients.

A life-threatening complication was reported after RB in one patient. The patient developed post-RB stridor secondary to subglottic edema that necessitated nebulized epinephrine and intravenous dexamethasone. However, the patient required endotracheal tube intubation and ventilation for 8 h until stridor was relieved. There were no deaths among the cases studied.

Table 3 Radiologic findings in patients with airway foreign bodies

Radiologic findings	*N* (%)
Normal	14 (34.1)
Obstructive emphysema	9 (21.9)
Atelectasis	8 (19.5)
Foreign body visualized	6 (14.6)
Pneumonia	4 (9.7)

Table 4 Types and anatomic location of foreign bodies

Types and anatomic location	*N* (%)
Types of foreign bodies	
Scarf pin	4 (9.7)
Seed	25 (60.9)
Peanut	6 (14.6)
Rosary bead	1 (2.4)
Disk pin	2 (4.8)
Plastic object	2 (4.8)
Unknown foreign body	1 (2.4)
Anatomic location of foreign bodies	
Trachea	5 (12.1)
Right bronchial tree	
Mainstem bronchus	14 (34.1)
Upper lobe	0 (0)
Middle lobe	2 (4.8)
Lower lobe	4 (9.7)
Left bronchial tree	
Mainstem bronchus	6 (14.6)
Upper lobe	0 (0)
Lower lobe	9 (21.9)
Not seen	1 (2.4)

Table 5 Complications during or after bronchoscopy retrieval of foreign bodies

Complications related to FOB through LMA	*N* (%)
Postbronchoscopic laryngeal edema	5 (12.1)
Transient hypoxia	5 (12.1)
Gastric distension	4 (9.7)
Mild hemoptysis	3 (7.3)
Low-grade fever	2 (4.8)
Complications related to RB	
Post-RB stridor	1 (2.4)

FBs, foreign bodies; FOB, fiberoptic bronchoscopy; LMA, laryngeal mask airway; RB, rigid bronchoscopy.

Discussion

This study shows that FOB through LMA is effective in the safe removal of nonasphyxiating pediatric airway FBs with minor, non-life-threatening complications, with the success rate reaching 83%.

Since the first bronchoscopy with a rigid esophagoscope performed by Killian in 1897 for FB removal [12], RB has remained the standard procedure for FB removal because of its advantage of a wide working channel and availability of required equipment for FB extraction [3,4]. In recent years, there have been notable reports of airway FB removal in adults and children, with FOB as the first choice [4,13–15]. The issue that remains unresolved is the choice of the examination technique (flexible versus RB) in children with suspected FB aspiration. The technological advancements of flexible bronchoscopes and its ancillary tools as well as the increasing experience of flexible bronchoscopists encouraged FOB usage in pediatric FB extraction.

The choice of a rigid instrument in pediatrics is preferable under certain circumstances such as in asphyxiating FBs [16] in very young children as it offers optimal ventilation and instrumentation [17,18], in FBs surrounded by scar and granulation tissue as a rigid forceps enables firmly grasp of the objects while pulling, rotating, or even pushing the impacted FBs [17], in very sharp-edged FBs that might damage the vocal cords [4,17], and finally in FBs that are too large to be withdrawn through the FOB and passed through the glottis [4,17]. However, a number of evidence-based clinical algorithms suggest that RB should be the first choice in all cases of asphyxia, radiopaque FBs, unilateral decreased breath sounds, obstructive emphysema, and significant mediastinal shift [14,16,19].

Compared with RB, FOB is a relatively less invasive, less costly, easy, and safe procedure in experienced hands and has many advantages in the therapeutic retrieval of FBs in children including distally wedged FBs [20], endogenous FB (mucus or blood plug) or special forms of FBs (powder or fluid) by vacuum aspiration or bronchoalveolar lavage [21], FBs in ICU and mechanically ventilated patients [4,20], in the endobronchial management of FBs surroundings (through clearing local inflammatory secretion, local administration of drugs and investigation of postobstructive infection). Also, video imaging can provide a clear and magnified view and reduces the risk of residual FBs; repeat bronchoscopy can also be avoided [22]. In addition, FOB is recommended as the first-choice initial diagnostic procedure in equivocal suspected pediatric tracheobronchial FBs aspiration by the American Thoracic Society [23] because RB is associated with high negative (11–46%) initial diagnostic rates in such situations [24,25].

A standard pediatric bronchoscope with a 3.6 mm external diameter and a 1.2 mm working channel when used in FB extraction has the following limitations: it requires a smaller diameter endotracheal tube (4.5 mm) that interferes considerably with ventilation and FBs retrieval forceps are too small to allow adequate grasping of foreign objects. Thus, this bronchoscope plays a very limited role in FB removal, except in highly skilled hands [4,26].

We have exclusively used FOB through LMA in FB extraction in pediatrics since our previous report in 2010 including five cases [10]. In the current study, we used LMA because of the following advantages: its comparatively large internal diameter allows the use of the FOB without a significant increase in airway resistance with efficient ventilation through the procedure compared with an endotracheal tube, the FB can be removed during the same setting with FOB without the need to shift to RB, the narrow nasal passages can be bypassed by the LMA introduced through the mouth, and an adult flexible bronchoscope can be used with a larger working channel, allowing a wide variety of larger FB forceps and tools, leading to firm adequate grasping of foreign objects [7,8]. The previously mentioned advantages of FOB in pediatric FB removal should be considered with the advantages of LMA in the evaluation of this technique.

In most cases, the pediatric patient does not tolerate bronchoscopy while alert [26]. Our anesthetists are concerned about the use of ‘conscious sedation’ in children; however, in many centers in the USA, cost factors and limited access to operating theaters have led to a preference for sedation and local anesthesia [26,27]. Thus, in the present study, we used general anesthesia during the procedure as it provides better control of the airway [26], offers adequate muscle relaxation, thus enabling easy introduction of the bronchoscope, steady bronchial caliber throughout the procedure, reduced likelihood of loss of the FB from the forceps during the removal [28], and the possibility to shift to the use of RB whenever needed [26].

In this study, more than half of the patients with airway FBs were younger than 3 years of age (53%); the majority were males (68%). FBs were more often lodged in the right bronchial tree than in the left bronchial tree (48 vs. 38%) and with a clear predominance of objects of organic origin (75.6%), mainly seeds (60.9%). These findings are in agreement with those of various other previous studies [10,29–31].

The technique of FB retrieval in the current study included different types of FBs, even an FB as challenging as a rosary bead [32]. However, an earlier report used this method only to extract watermelon seeds in five cases [8].

Radiologic findings in aspirated FBs are variable [33]. Chest radiographs were completely normal in 34.1% of the current cases studied. Similar findings were obtained in which between 10 and 40% of patients with endoscopically confirmed aspirated FBs did not have abnormalities in their chest radiographs [19,33,34].

The average success rate of FB removal using FOB in 457 adults during the 1970s to the 1990s was 83.6% (61–97%) [20], whereas success rates of 91.3, 100.0, and 91.3% were retrospectively recorded in 23, 24, and 938, children, respectively, who underwent flexible bronchoscopic FB extraction [1,3,4]. In our unit, we prospectively used FOB through LMA in FB extraction in pediatrics with a success rate of 82.9%.

If flexible bronchoscopy fails, RB is the next step. Extraction of six of seven FBs with long history of aspiration that could not be removed by FOB through LMA was successful with the use of RB. Thus, pulmonologists who are interested in FB removal should be trained in the use of RB with the possibility to shift from the use of flexible to RB whenever necessary as an ultimate weapon for FB retrieval [17].

Most bronchoscopic extractions of FBs, if performed appropriately, result in minimal to mild complications and negligible or no mortality related to bronchoscopy itself [35]. There were no significant complications related to FOB through LMA, all of which were alleviated rapidly. However, a critical post-RB stridor was reported in one patient. It must be noted that complications can and do occur even with RB [14,19,25,34,36].

The study has certain limitations. None of our patients underwent nonasphyxiating or nonemergency tracheobronchial FB aspiration. Also, the mean age of the patients studied was relatively high (5.9 years). These limitations may have influenced our results.

In conclusion, LMA is a safe and effective adjunct to FOB under general anesthesia in pediatric FB retrieval, allowing the use of an adult-size bronchoscope with minimal complications. FOB through LMA could be considered as the first choice for the removal of nonasphyxiating airway FBs, with ready availability of skilled personnel and suitable equipment to immediately proceed with rigid bronchoscopic extraction if flexible bronchoscopy fails. Further prospective studies should be carried out to determine whether it should be a first choice in all cases of nonasphyxiating airway FBs.

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Conflicts of interest

There are no conflicts of interest.

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