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May the first-line treatment for foreign body aspiration in childhood be flexible bronchoscopy?

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Abstract:

INTRODUCTION: Rigid bronchoscopy (RB) is the traditional treatment in foreign body (FB) aspiration in childhood but is a traumatic and invasive procedure. However, flexible optic bronchoscopy (FoB) is a noninvasive and nontraumatic respiratory intervention. The aim of this study was to evaluate FoB as a first-line treatment modality in pediatric cases presenting with a preliminary diagnosis of FB aspiration.

METHODS: Subjects who underwent FoB under general anesthesia with the preliminary diagnosis of FB aspiration were enrolled in this cross-sectional study. Two cases were inherited from pediatric surgery because they were not removed with FoB. The demographic, clinical, and radiological findings at the presentation were recorded. Results of success rate and complications were recorded.

RESULTS: Among the FB aspiration cases age range of 7 months to 16 years. FoB demonstrated a FB in the airways of 31 (62.2%) subjects. The duration of the symptoms in the subjects was 9.1 ± 8.8 days. Three of the cases were taken over from pediatric surgery because they were not removed with RB. Most commonly encountered FB's were organic materials ($n = 20$, 64%). FoB was successful in removing the FB from the proximal and also distal airways in 93% of the subjects. No significant complications and side effects were observed except post-FoB cough.

CONCLUSION: This result has shown that FoB for the treatment of FB aspiration is successful in removing FB aspiration from both the proximal and distal airway that the RB cannot remove. Furthermore, FoB did not have any significant airway complication. FoB may be used as the first-line treatment modality for FB aspiration instead of RB in childhood the fact that noninvasive and nontraumatic respiratory intervention.

Keywords:

Aspiration, childhood, flexible bronchoscopy, foreign body, treatment

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Introduction

Foreign body (FB) aspiration in children is a condition that can cause serious morbidity or even mortality and requires early diagnosis and treatment. It is the fourth leading cause of death in children due to accidents under 3 years of age and third in children under 1 year of age.[1-3] In 2016, the lethal asphyxiation rate of children under 5 years of age in the general population was reported to be 0.43/100,000, and the frequency of nonfatal food-induced asphyxiation under 14 years of age was reported to be 29.9/100,000.[4] The most frequently aspirated foreign bodies are food particles.[5-7] Rigid bronchoscopy (RB) has been used as a conventional first-line treatment option in the treatment of FB aspiration in childhood.[8,9] However, it has severe complications of RB moreover some of them may be severe.

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Box-ED

What is already known on the study topic?

Foreign body (FB) aspiration is an important cause of morbidity and mortality in childhood

Rigid bronchoscopy (RB), which has more complications than flexible optic bronchoscopy (FoB), is used in the treatment of FB aspiration in childhood.

What is the conflict on the issue? Is it important for readers?

RB has been used as a conventional first-line treatment option in the treatment of FB aspiration in childhood

FoB may be a much less traumatic and uncomplicated method if additional instruments can be used in childhood foreign body aspiration cases.

How is this study structured?

This was a single-center, retrospective cross-sectional study that includes data from 31 patients.

What does this study tell us?

FoB is an effective method in the diagnosis and treatment of pediatric foreign body aspiration

FoB is the only noninvasive option for foreign bodies in the airway branches and ends, as the RB cannot reach foreign bodies.

Flexible optical bronchoscopy (FoB) is a commonly used method in the anatomical and functional evaluation of both the upper airway and the tracheobronchial tree in childhood. FoB is used for both diagnostic and therapeutic purposes in children. Compared to RB, respiratory trauma, postoperative complications, and dental injuries are very rare with FoB.[10] Considering all these, FoB may be a much less traumatic and uncomplicated method if additional instruments can be used in childhood FB aspiration cases. In the literature, the success rate of removal of foreign bodies by flexible optic bronchoscopy (FoB) was reported to be 92% and 91% by Kapoor *et al*.[11] and Tang *et al*.,[12] respectively.

The aim of this study was to evaluate the efficacy and safety of FoB as the first-line treatment in children with a preliminary diagnosis of FB aspiration.

Methods

Study design and ethics committee approval

This retrospective cross-sectional study was approved by the Institutional Review Board of Celal Bayar University, School of Medicine (date of approval: 15/10/2019, number of approval: 54). Since it is a retrospective study, informed consent was not required.

Study population

Patients aged 7 months–16 years who presented to the Departments of Pediatric Emergency and Departments of Pediatric Pulmonology with cough and wheezing between 2014 and 2019 and underwent FoB with the presumptive diagnosis of FB aspiration were enrolled in this study. FB aspiration presumptive diagnosis relied on localized respiratory signs on examination, local air trapping or atelectasis on chest X-ray, or FB aspiration witnessed by the family.

Data collection

Age, sex, symptoms at presentation, duration of symptoms, and physical examination signs and posteroanterior (PA) and lateral chest X-ray findings, FoB findings, type of FB detected, and type of catheter used for removal of the FB (N-Gage (Cook Medical, USA), or Tripod catheter (Omnimed, UK) were recorded. Moreover, success in removing the FoB as well as the post-FoB complications was recorded.

Flexible optical bronchoscopy procedure

FoB procedure was performed by one of the researchers using Fujinon EB-470S (external diameter 4.9 mm, internal diameter 2 mm) or Fujinon EB-470P (external diameter 3.8 mm, internal diameter 1.2 mm) depending on the age and body weight of the subject. General anesthesia via NO_2 inhalation by mask and IV propofol is used during the procedure and IV neuromuscular blockers (Rocuronium, Esmeron, Merck Sharp Dohme) are used in selected subjects. All subjects are monitored for cardiac and respiratory parameters at operating room conditions and the procedure is videotaped. After the procedure, the subjects are followed up at 30 min intervals for respiratory and other complications such as persistent cough, laryngospasm, bronchospasm, hemoptysis, fever spikes for at least 2 h. If this follow-up is uneventful, the patient is observed for another 4 h and discharged from the hospital on the same day.

Statistical analysis

Data analysis was performed using SPSS version 22 (IBM Corp, Armonk, NY, US). Statistical analysis included descriptive statistics, Student's *t*-test, Pearson Chi-square tests, and Mann–Whitney analysis. Group comparisons were performed using Student's *t*-test for continuous variables and Chi-square test to compare categorical variables. Categorical variables were reported as frequency and percentage. Mann–Whitney U-test was used to compare continuous variables not normally distributed between patients with and without FB aspiration. $P < 0.05$ was considered statistically significant.

Results

Sociodemographic characteristics of the study group

We enrolled 52 subjects that underwent FoB with the preliminary diagnosis of FB aspiration and FB

was detected in 31 (62.2%). Among the FB aspiration subjects, 16 (52%) were male, and age range of 7 months–16 years (mean ± standard deviation [SD] 2.3 ± 2.8 years). Sociodemographic characteristics were not significantly different between FB (+) and FB (−) groups [Table 1].

Clinical characteristics of the study group

Symptom duration at the time of presentation ranged from 1 to 50 days (mean ± SD 9.1 ± 8.8 days) in FB (+) subjects. Among the FB (+) subjects, cough was the only symptom in 61% (n = 19), while 19.5% (n = 6) had cough and fever, 16.5% (n = 5) had cough and wheezing. Rarely, chest pain and hemoptysis were the presenting symptom. Similarly, cough was the most symptom in 86% (n = 18) of the FB (−) subjects [Table 1].

PA chest X-ray demonstrated local changes in aeration in 58% (n = 18) FB (+) and in 76% (n = 16) FB (−) subjects. Other pathologic PA chest X-ray findings were consolidation (23% vs. 14%). PA chest X-ray was normal in 19% (n = 6) of patients with FB aspiration [Table 1].

Flexible optic bronchoscopy results

FoB was successful in removing the FB from the airway in 93.5% (n = 29) of the 31 subjects. In the remaining two, the procedure was concluded with RB due to the intense granulation tissue secondary to the long FB duration. The catheters used to remove FB with FoB were N-Gage catheter (Cook Medical, USA) in 16 cases, by Tripod (Omnimed, UK) catheter in 13 cases, and by N-gage and Tripod catheters together in 13 cases. The localization of the FBs removed with FB was right main bronchus in 23% (n = 7), right lower lobe in 19% (n = 6), right middle lobe in 3% (n = 1), right upper lobe in 6% (n = 2), left main bronchus in 23% (n = 7), left lower lobe in 12% (n = 4), left upper lobe in 10% (n = 3), and trachea in 3% (n = 1) .The most common FBs encountered were nuts (hazelnut, walnut, almond, peanut, and kernel) in 69% (n = 20) of the cases. In seven subjects, foreign bodies of organic quality were removed, while plastic toys were successfully removed in two.

Postoperative complications

Subjects were followed up for persistent cough, laryngospasm, bronchospasm, hemoptysis, and fever spikes as postoperative complications. However, no complications were observed during and after the procedures.

Discussion

The use of N-Gage/Tripod catheters (Cook Medical, USA/Omnimed, UK) with FoB in the treatment of FB aspiration has been shown to be effective in FB aspiration subjects presenting early before the development of granulation tissue in the airways. Side effect incidence was similar between subjects who had FB detected and removed and who did not.

The duration of symptoms in the subjects enrolled ranged from 1 to 50 days. Only 9% (n = 3) of the patients with FB aspiration presented to the hospital within the first 24 h, 23% (n = 7) in the first 3 days, 26% (n = 8) in the first week, and 42% (n = 13) after 1 week. The delay in the presentation was due to the parents not witnessing the aspiration event or due to the missed diagnosis. Similarly, in previous studies, duration between the event and presentation to the hospital in cases with a diagnosis of FB aspiration has been reported to range from 2 h to 5 weeks.[13] The longer the FB stays in the airways, the higher the rate of granulation and epithelization in the airways.[14] Intervention here with RB causes increased local trauma and bleeding.[15] However, we did not observe local bleeding and trauma in FoB.

In our research, cough was the most common complaint among FB (+) subjects. The first complaints in the acute stage are cough and dyspnea.[16] Diagnosis becomes difficult as the time elapses and finally complications

Table 1: Sociodemographic and clinical characteristics of cases with and without detection of a foreign body

	With FB aspiration (n=31)	Without FB aspiration (n=21)	P
Boys*	16 (52)	14 (66)	0.63#
Age (years)**	2.3±2.8	2.7±3.0	0.32##
Duration of complaints (days)**	9.1±8.8	7.0±4.2	0.53###
Application complaint			
Cough*	19 (61)	18 (86)	
Cough and wheezing*	5 (17)	2 (9.5)	
Cough and fever*	6 (19)	1 (4.5)	
Cough and hemoptysis*	1 (3)	0	
Chest X-ray findings			
Hyperaeration*	18 (58)	16 (76)	
Consolidation*	7 (23)	3 (14)	
Normal*	6 (19)	2 (10)	

*Expressed as, n (%),**Expressed as mean±SD, #Pearson Chi-square test, ##Student t-test, ###Mann-Whitney U test. SD: Standard deviation, FB: Foreign body

related to FB develop.[17] In our study, systemic antibiotic treatment was not prescribed to any subjects with fever and consolidation on PA chest X-ray with the diagnosis of pneumonia after FB aspiration. It is also laryngospasm, which is a common complication after RB.[15] Postbronchoscopic laryngospasm was not observed in any of our cases.

The most common radiological pathology following FB aspiration is the formation of air confinement in the region of the FB.[18] However, most of the FBs aspirated into the airway are radiolucent.[19] Our research's most common radiological finding in FBA was air trapping, but some cases have nonspecific PA chest radiograph findings for FB aspiration. It is important to emphasize that a normal chest X-ray is inadequate to rule out the diagnosis of FB aspiration. Therefore, if the family persistently gives a history of FB aspiration, bronchoscopy should be performed more frequently. However, RB does not want a family because it is a traumatic operation. Many children have gum injury or tooth loss during RB.[15] There is no gingival, tooth, or oropharyngolaryngeal injury in flexible bronchoscopy. For this reason, families are considered more comfortable. For this reason, FB aspiration can also be the first method that can be used more frequently.

In our study, the FBs were most commonly detected in the right main bronchus and its branches. Anatomically, the trachea continues with the right main bronchus directly without an angle, while the junction of the left main bronchus and the trachea is more angled; therefore, the possibility of FB aspiration is higher in the right lung.[17,20] Similarly, previous studies have reported that FBs were detected more frequently in the right main bronchus and its branches, whereas the opposite has also been reported.[21,22] Although RB can reach the right main and left main bronchus, it cannot reach the more distal branches and more importantly the ends. For this reason, RB is insufficient for FB aspiration running distally. However, with FoB, any FB aspiration at branches and ends can be intervened. In our first case, the FB was in the left upper lobe apico-posterior segment. Pediatric surgery had attempted many times and was unable to remove the FB. Thereupon, pediatric surgery thoracotomy and bronchotomy were indicated. However, we took over the patient and removed the FB with the N-gage, which we adapted to 3.9 width FoB.

FB was detected in 60% of 52 cases enrolled and was successfully removed by FoB in 93% of cases. The FB had to be removed with RB in only two cases due to the severe granulation tissue around the FB posing a significant risk of hemorrhage. In a 5-year study of Tenenbaum *et al*.,[23] 28 FB aspirations in the airways were successfully treated with FoB. Swanson *et al*.[24] in a retrospective study, reported that 62% (n = 24) of FB aspirations in the airways were treated with flexible bronchoscopy in 11 years. Common complications during bronchoscopy are bleeding due to trauma to the airway mucosa, airway perforation, laryngeal spasm, pneumothorax, hypoxia, bradycardia secondary to hypoxia, cardiac arrest, and rarely death.[25,26] Bakal *et al*.[27] reported transient complications in 37.6% of the cases and death in 1.5% in their study of 513 cases using RB. Moreover, complications such as cardiac arrest, postoperative arrest, bronchial rupture, severe bronchospasm, postoperative infection, and multiorgan failure have been reported during and after FB removal by RB.[28] Zaytoun *et al*.[29] reported severe complications such as dyspnea, pneumothorax, and cardiac arrest requiring tracheotomy or assisted ventilation in patients undergoing RB for the treatment of FB aspiration. Fidkowski *et al*.[28] reported that the rate of nonfatal major complications (such as respiratory complications, hypoxic brain damage, and cardiac arrest) was approximately 1/150 in cases of FB removal by rigid or flexible bronchoscopy from the respiratory tract, and the rate of other serious complications (such as infection, failed bronchoscopy, bleeding, and thoracotomy) as 1/100 and mortality rate as 1/300. In our study, FB could not be removed from the airways in two subjects (6%) due to the presence of serious granulation tissue around the FB posing a significant hemorrhage risk. There were no complications after the procedure in any patient. Cardiac, respiratory, and infectious complications during or after FoB were not encountered.

Conclusion

FoB is an effective method in the diagnosis and treatment of pediatric FB aspiration. In addition, it is the only noninvasive option for foreign bodies in the airway branches and ends, as the RB cannot reach foreign bodies. Because of this feature, it reduces surgical applications in FB aspiration treatment. Complications are unexpected in experienced hands. Therefore, it may be considered as the first-line treatment of pediatric FB aspiration leaving RB for foreign body aspiration cases.

Author contribution statement

Study conception and design: Hasan Yüksel, Özge Yılmaz.

Data acquisition: Hasan Yüksel, Özge Yılmaz, Adem Yaşar.

Analysis and data interpretation: Özge Yılmaz, Arzu Açıkel, İsmet Topçu.

Drafting of the manuscript: Özge Yılmaz, Arzu Açıkel, İsmet Topçu, Adem Yaşar.

Critical revision: Hasan Yüksel, Özge Yılmaz.

Submit this form with the manuscript. Hasan Yüksel, Adem Yaşar.

Conflicts of interest
None Declared

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