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ORIGINAL ARTICLE

Urgent Bronchoscopy for Foreign Body Aspiration 48 Children among 1096 Patients

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ABSTRACT

Objective: Foreign body aspiration is a potentially life-threatening emergency in children. Urgent rigid bronchoscopy should be performed when presentation includes severe respiratory failure with suspicion for FBA. To the best of the knowledge, this is the first study that evaluates URB in English literature.

Methods: Forty-eight patients who underwent urgent rigid bronchoscopy were included in this study. From the medical records, the patients' demographic characteristics, hospital arrival time, endotracheal intubation status, peripheral oxygen saturation, bronchoscopy results, type and location of foreign body , intraoperative and postoperative complications, mortality, X-ray results, length of hospital stay were evaluated.

Results: Twenty-four of the 48 patients were non-intubated. Peripheral oxygen saturation values were 60±14.40 in the preoperative period. There was not any statistically significant difference between intubated and non-intubated patients in terms of intraoperative and postoperative complications. There was not any statistically significant difference between patients with negative and positive results for bronchoscopy in terms of intraoperative and postoperative complications.

Conclusions: Bronchoscopy is not without risk; however, it is a life-saving procedure. Despite negative foreign body results, urgent bronchoscopy should be performed in suspicious cases.

Key words: Foreign body, aspiration, pediatric, urgent bronchoscopy.

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INTRODUCTION

Respiratory emergencies are one of the most common reasons parents seek evaluation for their children in the emergency department (ED). Respiratory failure is the most common cause of cardiopulmonary arrest in pediatric patients [1]. Foreign body (FB) inhalation or aspiration is the sixth most common cause of accidental death in children in the United States [2]. Foreign body aspiration (FBA) remains a common and life-threatening emergency in children in spite of improved recognition and management.

Seventy percent of FBA occurs in children aged younger than 3 years [3]. There are developmental factors specific to this age group that increase their risk for aspiration including lack of posterior molar dentition, poor coordination of swallowing, the higher position of the epiglottis, easy distraction, talking or crying during eating and oral exploration [4,5]. Children with FBA have a wide range of presentation to the ED from the non-symptomatic application with FBA history to cardiopulmonary arrest, depending on the anatomic location of the FB,

the degree of airway obstruction, the elapsed time from aspiration to hospital admission, and the presence of complications [5].

In both adults and children, airway obstruction is associated with severe hypoxia and cells are negatively affected by inadequate levels of oxygen [6]. In this case, urgent bronchoscopy is a life-saving method for patients with FBA who have a respiratory failure (poor or absent respiratory effort, poor skin color, obtunded mental status). We aimed to evaluate urgent bronchoscopies applied to children who had poor clinical status in the ED and to determine the objective criteria for patients who need to undergo urgent bronchoscopy.

MATERIALS AND METHODS

Medical records of 1096 children who underwent rigid bronchoscopy between January 2005 and December 2016 in departments of thoracic surgery and pediatric surgery of two universities were reviewed retrospectively. Forty-eight patients with severe respiratory failure and strongly suspected FBA were included in this study.

All patients underwent rigid bronchoscopy (RB) within 30 minutes. The exception of endotracheal intubation for clinical and respiratory stabilization, RB was given priority over all other stabilizing treatment (e.g., bronchodilator treatment), fasting period completion, and radiologic examinations.

Standard monitoring (electrocardiography, non-invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide) was applied to patients in the operating room. Rigid bronchoscopy was performed under general anesthesia. General anesthesia and RB were performed by experienced anesthesiologists and thoracic surgeons or pediatric surgeons, respectively. The sizing of the RB (Karl StorzTM, Germany) was made in accordance with the manufacturer's recommendations. Patients with negative RB underwent esophagoscopy at the same time. A single-dose antibiotic was given, intravenously. Prednisolone (1 mg/kg) was administered intraoperatively to prevent airway edema. After bronchoscopy, all patients were transferred to the intensive care unit (ICU) where they received standard monitoring. The patients who were intubated received mechanical ventilation. Cold steam and nasal oxygen were administered to non-intubated patients. Chest X-ray was performed 4 hours after bronchoscopy in all patients. Follow-up of the patients included a physical examination and chest X-ray on the 10th day after discharge.

From the medical records, the patients' age, sex, hospital arrival time, physical examination findings in the ED, endotracheal intubation status, peripheral oxygen saturation (SpO2), bronchoscopy results, type and location of FB, intraoperative and postoperative complications, intraoperative and postoperative mortality, chest X-ray results, medical treatments after bronchoscopy and length of hospital stay were recorded.

Statistical analysis

All analyses were performed using SPSS Statistics, version 20.0, IBM. Descriptive statistical methods were used to analyze the data. Categorical variables are expressed as number and percentages, whereas numeric variables are expressed as the mean and standard deviation or the median and interquartile range (IQR), where appropriate. The Chi-square test was used to compare categorical variables between the groups. The statistical level of significance for all tests was considered as 0.05.

RESULTS

Forty-eight patients were analyzed in this study. Demographic characteristics including sex, age and hospital arrival time are shown in Table 1.

Table 1. Demographic characteristics

Characteristics	
Gender (F/M)	14/34
Age (month)	
Mean ± SD	26.92±23.10
Median (IQR)	18 (17.5)
Hospital arrival time (min)	
Mean ± SD	108.96±85.86
Median (IQR)	90 (105.0)

Twenty-four (50%) patients were intubated in hospital (n=12, 25%) or before arrival to hospital (n=12, 25%). Peripheral oxygen saturation values (presented as median and Inter Quantile Range) were 60±14.40 in the preoperative period. Physical examination and preoperative chest X-ray results are presented in Table 2.

Table 2. Preoperative evaluations of patients

	Foreign body		
	Positive	Negative	Total
	(n = 39)	*(n =9)*	*(n = 48)*
Chest X-ray			
None	24 (66.7%)	5 (41.7%)	29 (60.4%)
Normal	6 (16.7%)	5 (41.7%)	11 (22.9%)
Atelectasis	1 (2.8%)	0(0.0%)	1 (2.8%)
Consolidation	0 (0.0%)	2 (16.7%)	2 (4.2%)
Asymmetric hyperinflation	5 (13.9%)	0 (0.0%)	5 (10.4%)
Auscultation findings			
Stridor	16 (44.4%)	4 (33.3%)	20 (41.7%)
Wheezing	7 (19.4%)	6 (46.2%)	13 (27.1%)
Unilateral diminished breath sounds	12 (33.3%)	2 (16.7%)	14 (29.2%)
Physical examinations			
Tachypnea	39 (100.0%)	9 (100.0%)	48 (100.0%)
Intercostal retractions	27 (75.0%)	5 (41.7%)	32 (66.7%)
Nasal flaring	24 (66.7%)	5 (41.7%)	29 (60.4%)
Cough	27 (75.0%)	6 (50.0%)	33 (68.8%)

Twenty-four (60.4%) patients underwent URB procedures at nighttime hours (16:00 pm to 07:59 am), and 19 (39.6%) underwent URB during daytime hours (08:00 AM to 15:59 PM). The result of bronchoscopy was negative in 9 patients (18.8%, 4 intubated and 5 non-intubated). Foreign bodies within the tracheobronchial tree and esophagus were removed in 39 patients (81.2%). The nature of the aspirated foreign bodies was food in 84.6% (mainly seeds, maize, and beans). In patients with negative FB, laryngotracheitis (n=5), pneumonia (n=3) and intoxication (n=1) were diagnosed in the postoperative period. The majority (n=16, 33.3%) of the foreign bodies were located in the right main bronchus and 10 (20.8%) were in bilateral bronchi (Table 3).

Table 3. Localizations of foreign bodies

	n (%)
None	9 (18.8%)
Right main bronchus	16 (33.3%)
Left main bronchus	4 (8.3%)
Bilateral bronchi	10 (20.8%)
Trachea	6 (12.5%)
Esophagus	2 (4.2%)
Oropharynx	1 (2.1%)

At the end of the surgery, all the patients were transferred to the ICU. Only 6 patients were intubated and received mechanical ventilation postoperatively. Postoperative chest X-rays of 42 patients were normal. Six patients had atelectasis (n=1, 2.1%), bilateral pneumothorax (n=1, 2.1%), and consolidation (n=4, 8.3%). Table 4 shows intraoperative and postoperative complications. The mortality rate was 6.2% (n=3) in the perioperative period. No statistical differences were found between intubated and non-intubated patients in terms of intra-and postoperative complications (p = 0.19 and p = 0.23, respectively).

Table 4. İntraoperative and postoperative complications

	n (%)
Intraoperative	
None	42 (87.5%)
Right pneumothorax	1 (2.1%)
Cardiac arrest-death	2 (4.2%)
Bleeding	1 (4.2%)
Tracheostomy	2 (4.2%)
Postoperative complications	
None	43 (89.6%)
Bilateral pneumothorax	1 (2.1%)
Pneumonia	1 (2.1%)
Death	1 (2.1%)

Additionally, there were no statistical differences between patients with negative and positive results for bronchoscopy in terms of intra-and postoperative complications (p = 0.69 and p = 0.18, respectively). In the postoperative period, 2 children with respiratory distress underwent repeat bronchoscopy within 4 days, and the result of the secondary procedures was negative for foreign body.

DISCUSSION

In this study, we evaluated the approach of urgent bronchoscopy under general anesthesia in life-threatening FBA in children. We found that urgent bronchoscopy in these patients was safely applicable regardless of preoperative fasting times.

In our study, the average age of the patients was 18 months, and the male/female ratio was 2.4/1. The demographic characteristics of the patients are compatible with similar series in the literature [7]. Children with airway obstruction were identifiable through the presence of severe respiratory distress and cyanosis. These patients should be transported to the hospital as soon as possible. In the present study, the average time of hospital arrival of patients was 90 minutes after aspiration. It is known that rapid intervention is associated with decreased edema and/or inflammation of the respiratory mucous membranes [7].

The nature of foreign bodies aspirated is similar to other studies in the literature. The majority of FBs were located in the right main bronchus. This is an expected location due to the anatomy of the airway. In this analysis consistent with other series, 33.3% of foreign bodies were removed from the right bronchus [8,9].

The anamnesis of the patient given by the parent is the most sensitive predictor of the presence of FBA [10]. In the current study, all patients were admitted to the ED due to suspected FBA history. Nevertheless, anamneses given by parents may be misleading and should be evaluated carefully. For example, the result of RB was negative in a male child aged 18 months with respiratory distress. After the procedure, the parents claimed that there may also be a suspicion of insecticide poisoning.

Physical examination findings are not as sensitive as anamnesis, but they are more specific [10]. In patients with suspected FB, the classical triad of preoperative signs and symptoms include a sudden cough, wheezing, and unilateral diminished breath sounds [3]. Respiratory rate and quality might also be helpful diagnostic information. Fast and shallow breathing (tachypnea) is often seen in upper airway obstruction [11]. Pinto et al. reported that cough and dyspnea were the most common symptoms [12]. In another study by Chui et al., cough (72%), dyspnea (64%), and wheezing (60%) were presented [13]. In our study, the most common symptoms were tachypnea (100%), cough (66.7%) and stridor (41.7%). As stated above, clinical presentations may present in a wide variety. Additionally, all patients had low SpO2 values. This is an important parameter for taking an urgent decision when evaluated together with other parameters because hypoxia is a life-threating event. Therefore, the diagnosis of FBA requires a high degree of clinical suspicion, especially in the presence of hypoxia.

In our study, RB was negative in 9 (18.8%) patients. In the literature, the rate of negative RB for FBA varies

from 1.5 to 17% [14]. Anatomic disorders, neuromuscular disorders, infectious diseases, croup, cord injuries, asthma attacks, and anaphylaxis should be considered in the differential diagnosis. Unfortunately, physicians do not have much time for detailed examinations when they face severe respiratory failure in a child with suspected FBA.

Another diagnostic parameter is chest X-ray, but the value in the diagnosis is controversial. A normal chest X-ray, which is seen nearly two-thirds of patients with FBA, may not rule out FBA [15,16]. In our study, the majority of patients (60.4%) did not undergo chest X-ray due to an emergent life-threatening event. All patients who had chest X-rays had their chest X-rays performed in previous hospital admissions. Eleven (22.9%) of the patients had normal chest X-rays. In this context, we can state that chest X-rays may be requested according to the general situation of the patients.

If a child has near-complete or complete airway obstruction, immediate airway intervention is required. In children with severe respiratory distress or respiratory arrest, endotracheal intubation should not be disregarded because it can provide effective ventilation. However, Worrell et al. reported that endotracheal intubation was not recommended in oropharyngeal FB to avoid potentially pushing the object more distally into the oropharynx [17]. In the current study, 24 (50%) patients were intubated in the hospital or before admission to hospital. We were not sure whether the FB had been pushed from the trachea to the right or left main bronchus during intubation before the URB procedure. Nonetheless, we think that endotracheal intubation might save a child's life because many children with complete tracheal FBA obstruction have no chance of reaching a hospital alive. Moreover, in patients who need intubation, we assert that urgent rigid bronchoscopy has a positive effect on the outcomes of patients who are transferred from the ED to the operating room at the earliest convenience.

In terms of surgery and anesthesia, the timing of the removal of aspirated foreign bodies is an important issue. Mani et al. stated that procedures should be implemented under optimal conditions in clinically stable patients in daytime hours, and delayed bronchoscopy was not associated with an increased risk of mortality and morbidity [18]. In a study conducted by Oncel et al., the proportion of positive bronchoscopy was more significant in the first 24 hours than in other time periods [14]. However, our ethos is that children with serious respiratory distress should be taken to the operating room as soon as possible, regardless of the time of day. We know that children are at risk in terms of aspiration and its complications when the fasting period is not completed [19]. In this instance, the subject to be discussed should be hypoxia and aspiration. Our attitude on this point favors the correction of hypoxia. With adequate technical equipment and experienced surgeon and anesthesiologist cooperation, we did not encounter aspiration as a complication during the procedure, because we believe that serious hypoxemia is a life-threating condition for children, and possible FB must be quickly removed from the airway. Rigid bronchoscopy is a key procedure for diagnosis and retrieval of a foreign body aspiration [20]. In addition, another important point is that RB must be performed by experienced anesthesiologists and surgeons to minimize possible complications.

In the current study, complications occurred due to FB aspiration but we encountered no procedure-related complications. Schmidt et al. reported that complication rates were associated with the length of time FBs stayed in the tracheobronchial tree [8]. In our series, the intraoperative and postoperative complication rates were 12.5% and 10.4%, respectively. The rates of complication including pneumothorax, perforation, cardiac arrest, and hemorrhage vary between 1.2% to 44% in the literature[8]. In the treatment one child who had a right-sided pneumothorax, tube thoracostomy drainage was performed during URB for the removal of the foreign body. The tracheotomy was needed in two patients: the first case was for the extraction large-sized FB from the incision, intraoperatively, and the second was for the aspiration of tracheobronchial blood due to a foreign body (broken glass) and 1:1000 adrenaline solution spray, postoperatively. In one child, bilateral pneumothorax was observed in the early postoperative period, which was treated with tube thoracostomy drainage. In one child who aspirated a chickpea, pneumonia developed in the postoperative period; and the boy was cured with antibiotic treatment. The cause of death in 3 patients was severe hypoxemia. Among them, one child was taken to the operating room after cardiopulmonary resuscitation and RB was negative for FB, but the patient did not respond to resuscitation in the URB. In the second patient who aspirated grain, the cardiopulmonary arrest occurred during RB, and she did not survive despite all interventions. Hypoxia plus reflex vagal stimulation and movement of the FB

within the tracheobronchial tree may cause cardiopulmonary arrest [21]. The third patient who aspirated a hazelnut died on the 2nd postoperative day of hypoxic brain injury. In our series, the mortality rate (6.2%) was higher than in other studies [8,9,19]. Therefore, we would like to repeat that with suspicion of a foreign body, hypoxemia is a life-threatening condition that requires urgent intervention. Additionally, we would like to emphasize that all references in the literature are about general FBA groups, not especially in emergency cases.

Patients with FB should be closely monitored in the postoperative period. Intubated patients were transferred to the pediatric ICU. We did not use routine antibiotics, except in nine patients who were diagnosed as having pneumonia and laryngotracheitis. The children were examined on the 10th day after hospital discharge for possible morbidities, and no co-morbidities associated with FBA were found during the examinations. The average length of hospital stay was 2 days. This period is relatively short for acute presentations compared with long-standing aspirated FB [8].

Limitations of our study were; small sample size and retrospective character. Thus, the results could not be generalized.

In conclusion, the objective criteria for patients who need to undergo urgent bronchoscopy are a severe respiratory failure and trusted parent's anamnesis. Bronchoscopy is not without risk; however, it is a life-saving procedure. Despite negative FB results, urgent bronchoscopy should be implemented in suspicious cases.

ETHICAL STATEMENT

University's Institutional Review Board (IRB) permission was approved for this retrospective study.

CONFLICT OF INTEREST

There is no conflict of interest for all authors.

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