

Complications of bronchoscopy for foreign body removal: experience in 1035 cases

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BACKGROUND: Tracheobronchial foreign body aspirations, which threaten lives in childhood, also carry potential risks during and after bronchoscopy. The aim of this study is to review complications and precautions that need to be taken against possible risks.

METHODS: From 1987 to 2005, bronchoscopy was done in 1035 children in our department on suspicion of foreign body aspiration. The average age of these patients, mostly male (55%), was 4.1 years. Medical history, physical examination, radiological methods and bronchoscopy were used in the diagnosis. Bronchoscopy was applied under general anaesthesia, and the respiratory and cardiac systems were closely observed for 4 hours after the process.

RESULTS: Nine hundred eleven of 1035 patients (88%) had a foreign body in the tracheobronchial system. In 42 of the patients, infection required aggressive medication; in 30, hypoxia and bradycardia occurred as a result of obstruction during bronchoscopy; in 37, laryngeal edema, laryngeal spasm and/or bronchospasm required ventilation support; in 6 patients, tracheobronchial system bleeding occurred; in 2 patients pneumothorax occurred, in 1 patient pneumomediastinum was observed and 6 patients needed thoracotomies because of foreign body aspiration. In this series there were 8 deaths.

CONCLUSION: Bronchoscopy, performed for tracheobronchial foreign body aspiration, carries a potential life-threatening risk during and after the process. The clinician needs to be aware of these risks, take proper precautions, and perform bronchoscopy by taking the medical condition of the patient and characteristics of the inspired foreign body into consideration.

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Foreign body aspiration is one of the most important causes of accidental deaths in childhood. Most of the deaths occur before reaching hospital. Taking the foreign body out of the tracheobronchial system is mostly life saving. For children who reach the hospital, the most appropriate choice of methods for removal of the foreign body is bronchoscopy. However, during and after bronchoscopy life-threatening complications can be observed.^{1,2} We review these complications in our series of bronchoscopies.

Methods

From 1987 to 2005, bronchoscopy was done in 1035 children in our department on suspicion of foreign body aspiration. The ages of the patients ranged from 1 month to 16 years, 571 were male (55%), and 464 were female. Reasons for admission to hospital are summarized in Table 1. Rigid bronchoscopy was performed in all patients. Chest

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Table 1. Reasons for admission to hospital.

Reasons	Number of patients (%)
Foreign body inhalation history and/or dyspnea	880 (85)
Resistant lung infection*	122 (11.6)
Clinical conditions like asthma bronchiale*	18 (1.7)
Casual radiological abnormality	11 (1)
Haemoptysis	4 (0.38)

*These patients received medical treatment before admission.

x-ray was done routinely except in 28 cases (2.7%) that had life-threatening asphyxia where there was no time for a chest x-ray. Computed tomography was done in 44 children (43%) in the evaluation of pulmonary complications due to foreign body inhalation. Bronchoscopy was applied under general anaesthesia with a rigid bronchoscope and optical forceps were used in some patients if required. All patients received anaesthesia with sevoflurane in nitrous oxide/oxygen (ratio 2:1). Propofol or thio-pental was used for induction at clinically required doses. Succinylcholine was used to facilitate bronchoscopy and repeat doses were only given if needed. Prednisolone was used in a 1 mg/kg dose for those who developed laryngeal edema or spasm after bronchoscopy.

For antibiotic prophylaxis, cefazolin sodium was administered before the bronchoscopy as a single dose of 50 mg/kg. After bronchoscopy, application of cold vapor, observation of respiration, and cardiac monitoring for 4 hours were carried out in the PACU.

Results

Nine hundred eleven of 1035 patients had a foreign body in the tracheobronchial system (88%). Most of the foreign bodies were organic objects (Table 2). In 109 (12%) patients, the location of the foreign body was in the trachea, in 473 (52%) it was in the right bronchial system, and in 429 (36%) patients it was in the left bronchial system. Radiological findings are shown in Table 3. In 30 patients, bronchoscopy was performed more than once to remove foreign bodies. Potential life threatening risk factors are shown in Table 4. Eight patients died during or after bronchoscopy. In 30 of 109 patients who had a foreign body located in the trachea, SpO₂ levels were under 70% and arrhythmias were observed during the bronchoscopy. In these patients, tracheal obstruction was nearly total or there was difficulty in grasping

the foreign body with forceps or removing it from the larynx. In 5 of these patients cardiac arrest occurred. Two patients, one who had a stone lodged at the carineal level and one who had a plastic pencil cap lodged in the trachea died because of cardiac arrest due to total tracheal obstruction.

In one 3-year-old male child with sudden cyanosis and dyspnea, no foreign body was observed during bronchoscopy. After the bronchoscopy, respiratory arrest occurred and in the autopsy of the patient a white transparent soft plastic object was found in the trachea. A 7-year-old female child was taken for bronchoscopy because of aspiration of cement powder. The obstruction was pervasive in both bronchial systems. Although bronchial cleaning was carried out as much as possible, high airway pressure was observed during mechanical ventilation, and the patient died due to respiratory failure 1 hour after bronchoscopy. A 9-year-old female child had a history of boiled bean aspiration 4 days earlier and the bean, which obstructed the right main bronchia and overlapped through the trachea, was seen during bronchoscopy. Since the bean was bigger than the diameter of the bronchoscope, the physician tried to grasp it with forceps and remove it with the forceps and bronchoscope, but the bean fell into the trachea and caused a total obstruction, which was seen when the bronchoscope was inserted into the trachea again. During the effort to grasp the bean again, the bean swelled, and was seen to be soft and fragile. The bean dissolved and scattered through both bronchial systems. The patient died because of cardiac arrest.

A foreign body was seen in the tracheobronchial system in 71 of 122 patients for which bronchos-

Table 2. Type of aspirated foreign body.

Foreign body	Number of patients
Vegetable matter	
Dried nuts	410 (45%)
Dried beans	262 (28.7%)
Undefined organic object	40 (4.1%)
Beaded needle	112 (12%)
Plastic object	70 (7.6%)
Metal object	12 (1.2%)
Stone	4 (0.4%)
Cement powder	1 (0.1%)

*These patients received medical treatment before admission.

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copy was applied because of pulmonary infection and suspicion of foreign body aspiration. In 42 of 71 patients, after the foreign body was removed, parental antibiotics and other medical treatments were necessary because of infection. A 5-year-old girl, who had a total obstruction in the right main bronchia due to a plastic object, had aspirated the object 2 months before, according to the parents. The foreign body, which caused total obstruction in the right main bronchia, was grasped and taken out during bronchoscopy. When the foreign body was removed, it was observed that pus, which had gathered in the distal end of the obstruction, dispersed throughout both bronchial systems, although aspiration was tried. The patient needed mechanical ventilation due to insufficient oxygenation after the bronchoscopy, and died because of respiratory failure and sepsis on the fourth day.

We performed bronchoscopy on two boys, aged 6 months and 9 months, to take microbiological samples and to determine if there was a possible foreign body in the tracheobronchial system. Both patients were undergoing medical treatment for heart failure and bronchopneumonia. In both children, foreign bodies, which were thought to be peanut particles, were taken out during the bronchoscopy. The 6-month-old child died 2 hours after the process, and the other child died the next day due to cardiopulmonary arrest.

Although the foreign body was taken out after the bronchoscopy, laryngeal edema, laryngeal spasm and/or bronchospasm with insufficient ventilation were observed in 37 patients. While 11 of these patients recovered with bronchodilator treatment, 26 required mechanical ventilation support for up to 48 hours. We observed bleeding in 6 patients during bronchoscopy. In all these patients, bleeding stopped with washing and aspiration.

We performed thoracotomy in 6 patients because of foreign body aspiration. Four of these patients needed pulmonary resection because of irreversible pulmonary damage such as bronchiectasis and destroyed lung. The other 2 patients had thoracotomy because of distally located foreign bodies, which could not be taken out by bronchoscopy. There were no complications or mortality in these patients. After bronchoscopy, we observed pneumothorax in the chest x-rays of two children. In these patients, tube thoracostomy was sufficient for the treatment. A patient who had pneumomediastinum after bronchoscopy needed no treatment and spontaneously recovered.

Table 3. Radiological findings.

Findings	Number of patients
Hyperinflation	310 (30%)
Atelectasis	269 (26%)
Radiopaque foreign body	155 (15%)
Bronchiectasis (CT)	6 (0.6%)
Pulmonary abscess (CT)	1 (0.1%)
Normal radiological findings	208 (20%)
Without chest x-ray*	28 (2.7%)

*We did not perform chest x-ray in 28 patients who had life threatening respiratory failure.

Table 4. Potential risk factors during and after bronchoscopy.

Risk Factors	Number of patients
Infection needed aggressive medication	42 (4%)
Hypoxia and bradycardia due to obstruction during bronchoscopy	50 (5%)
Laryngeal edema, laryngeal spasm, bronchospasm needed ventilation support	37 (3.8%)
Trachea bronchial system bleeding	6 (0.6%)
Thoracotomy	6 (0.6%)
Pneumothorax	2 (0.2%)
Pneumomediastinum	1 (0.1%)

Discussion

Tracheobronchial foreign body aspiration is the most common cause of death due to acute asphyxia among children.^{2,3,4} Death takes place in a short time in total tracheal obstruction. If only a little air can flow, patients may not have much time to reach the hospital. Another danger is that with strong respiratory effort, a partial obstruction with the foreign body or mucosal edema can turn into a total obstruction. The placement of foreign bodies is laryngotracheal in about 10% in the literature.⁴ In our series this rate was 12%. In 5 patients in our series, the cause of death was asphyxia. During bronchoscopy, tracheal obstruction occurs because of difficulty in removing the foreign body, which usually results from not being able to hold the object with a proper forceps. As we saw in one of our cases, round and stiff objects having smooth surfaces cannot be easily grasped with forceps. The time spent trying to recognize and remove the object during bronchoscopy usually does not leave enough time for tracheotomy. If total obstruction is in the proximal part of the trachea,

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percutaneous tracheal cannulation can be life saving. In our series, aspirations of a stone and a plastic pen cap were distally located. It is rare not to be able to see the foreign body during the bronchoscopy, when it is located in the trachea. However, it should be kept in mind that even an experienced bronchoscopist might not be able to notice transparent objects having a mucosal colour, especially those behind the vocal cords. These objects, as in one of our cases, may cause total obstruction. If aspiration anamnesis exists, the characteristics of the object should carefully be taken into consideration before initiating the process of removal. The swelling of the inhaled object by absorption of moisture and changes in the form of the obstruction have been reported in the literature.⁵ Organic objects are especially apt to taking moisture. Nevertheless, inorganic objects can also be observed to swell in the airway.⁶ In our series, we saw swelling in the case that had aspirated cement powder when the powder hardened inside the mouth and trachea. In this case, after opening of the tracheal airway, it was observed that the distal bronchial system was partly filled with cement, and this was the cause of the death.

While removing an object located in the main bronchia, it is possible for it to cause obstruction if it falls in the trachea. Objects that are too big to be taken out with the bronchoscope should be firmly grasped with forceps, when being taken out by bronchoscopy. When the size of the object is larger than the laryngeal gap, which can happen when the object is grasped on one side with the forceps and turned, the object can be grasped right in the middle. If this is not possible, it should be grasped simultaneously with two forceps on both sides.

Life-threatening risks before and during bronchoscopy are not limited to asphyxia. Infection caused by foreign body aspiration is one of the most important risks. As occurred in two of our cases, bronchopneumonia can be the cause of mortality, especially in young children, even if the object is removed. Pulmonary infection due to a foreign body aspiration is frequently reported in the literature.^{7,8} Chronic infection can cause pulmonary tissue de-

struction such as lung abscess, bronchiectasis and destroyed lung.^{5,9} In this case, first of all, the object should be removed, and pulmonary resection, which may be necessary, should be planned after treatment of the infection. In one of our cases, after the plastic object in the right main bronchia was removed, pus, which had gathered in the distal end of the obstruction caused by the object, filled the other bronchial system as well. In this situation, if pus coming from the distal had been aspirated after the object had been displaced and then taken out, respiratory failure would not have been added to complications of sepsis. Either the foreign body or the process of bronchoscopy can cause damage to the tracheobronchial system.^{1,10,11} This damage can be so severe as to require open surgical repair. Invasive forceps should be used more carefully, especially in cases in which infection and granulation have developed in the mucosa. Laryngeal edema and laryngeal/tracheal/bronchial spasm are complications, which can develop depending on the length of the process during rigid bronchoscopy.^{1,7} Edema and spasm may get worse due to aggressive manipulations when removing the object. Granulation tissue due to a foreign body usually increases with the length of time the object is in the bronchial system. On the other hand, rapid bronchial impairment is reported with the aspiration of some objects, like ferrous sulphate tablets.^{12,13} During bronchoscopy, bleeding usually occurs because of the granulation tissue and mucosa damages, and is rarely serious.^{12,14,15} It is reported that especially sharp objects like needles rarely leave the bronchopulmonary system.¹⁶ Situations requiring invasive operations to remove objects that are too distally located for bronchoscopy carry life-threatening risks. Although bronchoscopy performed to remove aspirated foreign bodies is a relatively an easy and common procedure, it carries preventable life-threatening risks during and after the process. Therefore, the clinician should take into consideration the characteristics of the inspired foreign body and the clinical condition of the patient during bronchoscopy.

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