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# Anesthesia management in pediatric bronchoscopy

Akif Demirel, Cevdet Yardımcı, Muhammed Nuri Polat

*Department of Anesthesiology and Reanimation, Faculty of Medicine, Yozgat Bozok University, Yozgat, Turkiye*

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**Corresponding Author:** Akif Demirel, akif_demirel19@hotmail.com

## ABSTRACT

**Aims**: The primary aim of this retrospective study is to analyze pediatric bronchoscopy cases performed under general anesthesia, evaluating the indications, findings, and adverse events.

**Methods**: The study included a total of 31 pediatric patients who underwent rigid and flexible bronchoscopy under general anesthesia at Bozok University Faculty of Medicine Hospital between July 1, 2018, and May 1, 2024. Demographic data, types of anesthesia, anesthetic agents, and length of hospital stay were recorded. Anesthesia management and surgical processes were described in detail.

**Results**: The study found that an increased duration of bronchoscopy was associated with a higher likelihood of laryngospasm and bronchospasm (p=0.049). Additionally, in line with the literature, the average age of patients included in our study who underwent bronchoscopy for diagnostic and therapeutic purposes was determined to be 33 months. The incidence of laryngospasm and bronchospasm was found to be 16.1%, which is consistent with other studies in the literature.

**Conclusion**: Our study indicates that foreign body aspiration occurs most commonly in male children under three years of age and that prolonged bronchoscopy durations increase the risk of laryngospasm and bronchospasm.

**Keywords**: Pediatric bronchoscopy, anesthesia, laryngospasm, bronchospasm, procedure duration

## INTRODUCTION

Bronchoscopy is an instrument used to visualize the upper and lower airways for diagnostic and therapeutic purposes.[1] It is considered as one of the most important diagnostic and therapeutic procedures in pediatric respiratory diseases.[2,3] The first report on diagnostic flexible bronchoscopy in children was published in 1978, and this method has revolutionized the management of pediatric respiratory diseases.[4,5] Over time, bronchoscopy has become an increasingly important tool in children with acute and chronic lung diseases. In 2003, the European respiratory society (ERS) task force published results related to flexible endoscopy of pediatric airways, indicating that this procedure is safe, provided that children are adequately prepared and the procedure is performed by competent and trained personnel.[6]

The ERS pediatric bronchology group conducted a survey in pediatric pulmonology centers in Europe from 2012 to 2014, revealing that a total of 56,145 bronchoscopies were performed in 198 centers, with the vast majority of these procedures conducted under general anesthesia.[7] This invasive endoscopic procedure is typically performed under deep sedation or general anesthesia to minimize the likelihood of movement in children and to prevent respiratory defense reflexes.[8] During bronchoscopy, benzodiazepines (midazolam), intravenous general anesthetics (propofol, etomidate, opioids), inhalational agents (sevoflurane, desflurane), or a combination of these anesthetic medications are generally used.[9-11]

Many studies have shown that surgical factors, anesthesia management, and the stability of pediatric patients contribute to unwanted respiratory events.[12] Particularly, patients who experience foreign body aspiration are often younger than 3 years, and it has been reported that the shared use of the airway with the surgical team may increase the risk of complications.[13,14] One of the most commonly encountered complications in pediatric bronchoscopy is hypoxemia; the literature indicates that prolonged procedure duration increases the frequency of these complications and also raises the risk of laryngospasm and bronchospasm.[15]

The primary aim of this retrospective study is to evaluate the indications, findings, and adverse events by analyzing all pediatric bronchoscopy cases performed under anesthesia between 2021 and 2024.

## METHODS

### Ethics

This study was approved by the Ethics Committee of Bozok University (Date: 06.03.2024, Decision No: GOKAEK-245_2024.06.05_76). This retrospective observational study was conducted at Yozgat Bozok University Faculty of Medicine Hospital, a tertiary healthcare center, this study included pediatric patients younger than 18 years old who underwent bronchoscopy procedure between July 1, 2018, and May 1, 2024. The study was conducted in accordance with the principles of the Helsinki Declaration.

### Participants

A total of 31 pediatric patients who underwent rigid and flexible bronchoscopy under general anesthesia during the specified dates were included in the study. Patients under 18 years of age who underwent bronchoscopy for diagnostic or therapeutic purposes were included. Patients with incomplete data were excluded.

### Clinical Data

Data on age, sex, weight, ASA physical status classification, admission diagnoses, type of anesthesia, anesthetic agents used, bronchoscopy technique applied, and length of hospital stay were recorded from the hospital automation system and file archive.

### Anesthesia Management

No sedation or analgesia was required for premedication in any of the patients. Routine monitoring was performed upon transferring patients to the operating room [electrocardiography (ECG), non-invasive blood pressure, and pulse oximetry ($SpO_2$)], and a 22-24 gauge IV cannula was placed in the dorsum of the right hand. All patients received a crystalloid infusion (8 ml/kg/hour) throughout the surgical procedure. Preoxygenation was performed with 100% $O_2$ for 3 minutes. Standard anesthesia induction was applied to all patients [2-3 mg/kg propofol (Propofol 1%, Fresenius®), 0.6-1.2 mg/kg rocuronium (Esmeron, MSD®), and 1 µg/kg fentanyl (Talinat, VEM®)]. After the placement of the laryngeal mask airway (LMA), patients were ventilated in controlled mode with a tidal volume of 8 ml/kg, $FiO_2$ 0.6, I ratio of 1:2, and $ETCO_2$ of 30-40 mm Hg. For maintenance of anesthesia, sevoflurane [minimum alveolar concentration (MAC) 0.8-1.3%] was administered with 60% $O_2$ and 40% air. If rigid bronchoscopy was necessary, an additional 0.1 mg/kg of rocuronium was administered for muscle relaxation. Intraoperatively, supplemental fentanyl (0.5 µg/kg) was used as needed.

All patients received 0.1 mg/kg metoclopramide and 10 mg/kg paracetamol IV (Partemol 1g/100ml, VEM) for postoperative nausea and analgesia within the last 30 minutes of the procedure. At the end of the surgery, for patients who received muscle relaxants, residual neuromuscular block was antagonized with a combination of IV neostigmine (50 µg/kg) and atropine (20 µg/kg).

### Statistical Analysis

The SPSS 20.0 software package was used for the analysis. Evaluations were performed using demographic data and general descriptive statistics (descriptive and frequency). The normality of the data distribution was assessed using the Kolmogorov-Smirnov test, and it was determined that the data did not follow a normal distribution. Analyses of relevant data were performed using the Mann-Whitney U and Kruskal-Wallis tests. A p-value of <0.05 was considered statistically significant.

## RESULTS

The analysis revealed that 67.7% (21) of the children who underwent bronchoscopy were male and 32.3% (10) were female. A foreign body was detected in 13 patients (41.9%). Complications developed in 5 patients following bronchoscopy (**Table 1**). The ages of the patients ranged from 6 months to 132 months, with a mean age of 33 months. Those with longer procedure durations had a higher incidence of bronchospasm and longer hospital stays (**Table 2**). All patients planned for flexible bronchoscopy underwent LMA placement. In 6 patients, it was determined that the procedure started with flexible bronchoscopy but continued with rigid bronchoscopy (**Figure 1**). A total of 13 patients (41.9%) had a foreign body detected (**Figure 2**). The development of desaturation and bronchospasm was more frequent in patients who underwent rigid laryngoscopy. All patients fully recovered during postoperative care. All patients who experienced complications were from the group with detected foreign bodies. Among the 13 patients with foreign bodies, 11 were male and 2 were female (**Figure 3**).

**Table 1.** Characteristics and percentage distribution of patients undergoing bronchoscopy

| | | n | % |
|---|---|---|---|
| Sex | F | 21 | 67.7 |
| | M | 10 | 32.3 |
| ASA | I | 19 | 61.3 |
| | II | 10 | 32.3 |
| | III | 1 | 3.2 |
| | IV | 1 | 3.2 |
| Airway; R or LMA | LMA | 19 | 61.3 |
| | R | 8 | 25.8 |
| | LMA+R | 4 | 12.9 |
| Foreign body | FB(-) | 18 | 58.1 |
| | FB(+) | 13 | 41.9 |
| Type of bronchoscopy | F | 17 | 54.8 |
| | R | 8 | 25.8 |
| | F+R | 6 | 19.4 |
| Bronchospasm/laryngospasm | B/L (-) | 26 | 83.9 |
| | B/L (+) | 5 | 16.1 |

F: Female, M: Male, ASA: American society of anesthesiologists score, LMA: Laryngeal mask airway, R: Rigid bronchoscopy, F: Flexible bronchoscopy, FB: Foreign body, B/L: Bronchospasm/laryngospasm

## DISCUSSION

In our study, the prolonged duration of rigid bronchoscopy was found to increase the likelihood of developing laryngospasm/bronchospasm. Additionally, it was noted that longer bronchoscopy durations led to increased hospital stay.

The need for bronchoscopy due to foreign body aspiration is common in children aged 1-3 years.[16] Massie et al.[17] identified that the most prevalent age group was between 1 and 3 years. Studies conducted in our country have also shown that cases of foreign body aspiration predominantly occur in male children under the age of three.[18] Consistent with the literature, our study revealed that the majority of patients undergoing

**Table 2.** Evaluation of airway complications

| | Laryngospasm/bronchospasm | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | L/B(-) | | | | L/B(+) | | | | |
| | Mean | SD | Min. | Max. | Mean | SD | Min. | Max. | p |
| Age (months) | 33.04 | 29.27 | 6.00 | 132.00 | 47.80 | 67.42 | 11.00 | 168.00 | .893 |
| Weight (kg) | 15.15 | 7.20 | 8.00 | 40.00 | 19.60 | 17.13 | 10.00 | 50.00 | .914 |
| Procedure duration (minutes) | 32.12 | 12.74 | 15.00 | 60.00 | 53.00 | 23.35 | 20.00 | 80.00 | **.049** |
| Length of stay (days) | 1.62 | 0.80 | 1.00 | 3.00 | 5.20 | 4.38 | 2.00 | 10.00 | **.017** |

Max: Maximum, Min: Minimum, SD: Standard deviation, p<0.05 indicates statistical significance

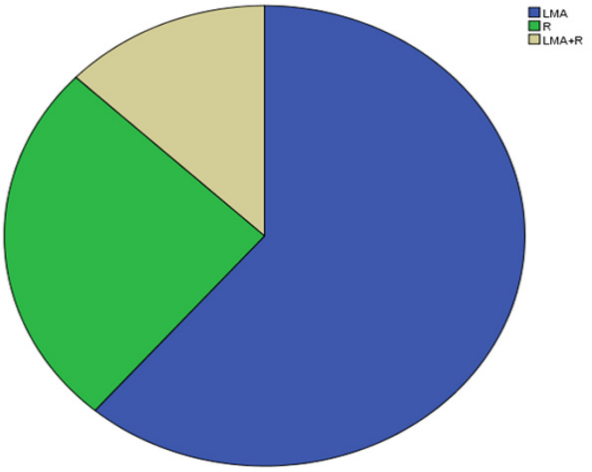


**Figure 1.** Airway control rates
LMA: Laryngeal mask airway, R: Rigid bronchoscopy

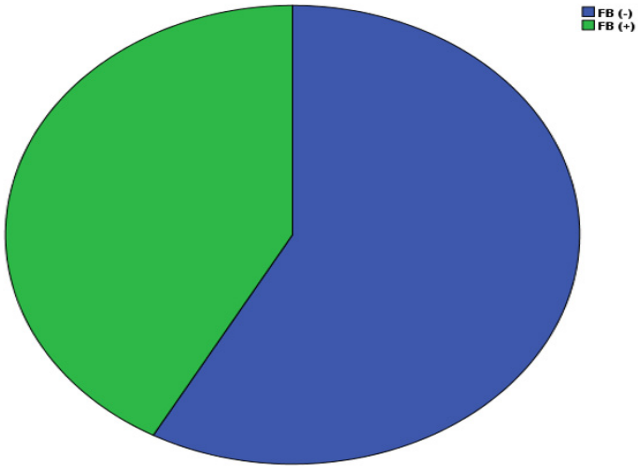


**Figure 2.** Results of foreign body detection in bronchoscopy
FB (+): Airway foreign body was found; FB (-): No airway foreign body was found

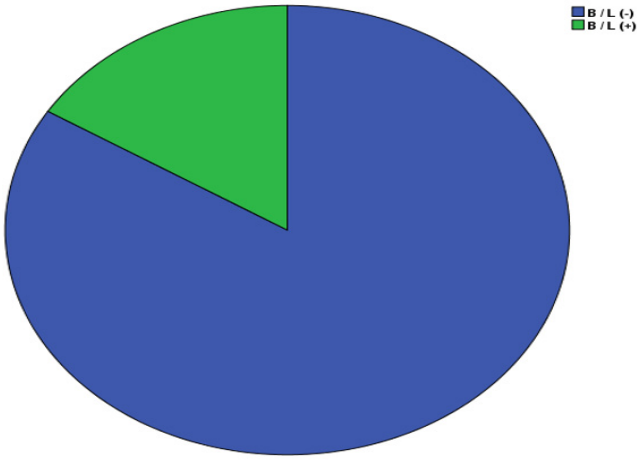


**Figure 3.** Incidence of bronchospasm/laryngospasm in bronchoscopy
B/L (+): Bronchospasm/laryngospasm was developed; B/L (-): Bronchospasm/laryngospasm was not developed

bronchoscopy for foreign body aspiration were male children under three years of age.

Anesthesia in bronchoscopy can be categorized into three areas: the choice of anesthesia method, ventilation during bronchoscopy, and maintenance of anesthesia.[19] However, there are different opinions in the literature regarding the anesthetic techniques used in pediatric bronchoscopy,[20,21] with reports of applications using either sedation or general anesthesia. The choice of anesthetic technique and agents is determined based on the characteristics of each patient and the planned ventilation technique (spontaneous/controlled). For complex procedures involving both rigid and flexible bronchoscopy, the gold standard remains general anesthesia.[22] Spontaneous or controlled ventilation techniques may be preferred for patients with foreign body aspiration, with both having their respective advantages and disadvantages discussed in the literature.[23] Several meta-analyses and reviews have reported lower frequencies of respiratory complications when controlled ventilation is applied.[24-26] In our clinic, controlled ventilation is preferred for bronchoscopy procedures. Patients undergoing controlled ventilation typically require a deeper level of anesthesia. Some studies have reported the use of propofol combined with remifentanil in anesthesia for flexible bronchoscopy in children.[27,28] In our clinic, propofol and fentanyl are used for flexible bronchoscopy procedures, while intravenous general anesthesia is applied with the addition of muscle relaxants for rigid bronchoscopies. Anesthesia practices and ventilation methods should aim to minimize the risk of complications for the patient.

In children, the most common cause of acute asphyxia is tracheobronchial foreign body aspiration.[18] Another danger associated with foreign body aspiration is the partial obstruction or mucosal edema that may occur due to the foreign body moving into the lower airways with strong respiratory efforts; this can significantly reduce lung ventilation and oxygenation.[29,30] Particularly in small children aged 0-3 years, anesthesia management can become challenging due to the shared airway with the bronchoscopist. This situation can lead to a higher incidence of serious postoperative airway adverse events, such as laryngospasm and bronchospasm, and can quickly result in severe hypoxemia.[31,32] In our study, the incidence of laryngospasm and bronchospasm was found to be 16.1%, which is comparable to the values of 17.6% and 17.4% reported in two retrospective studies evaluating complications of foreign body aspiration in China.[31,33]

During bronchoscopy, it can be quite difficult to achieve and maintain an appropriate depth of anesthesia to prevent reflexes such as laryngospasm and bronchospasm while also sustaining spontaneous respiration.[19] Some studies indicate that prolonged procedure times in bronchoscopy can lead to perioperative complications in children.[23,33] Procedure time

has been reported as an independent risk factor for predicting intraoperative desaturation, laryngospasm, and bronchospasm during the removal of foreign bodies in pediatric patients.[34] Similarly, in a study by Zaytoun et al.[29] a significant increase in complication incidence was observed in patients whose bronchoscopy procedures lasted 30 minutes or longer. In our study, patients with longer bronchoscopy durations had a higher frequency of laryngospasm and bronchospasm, which aligns with the findings of Yu Cui et al.[33] and Maddali et al.[35]

### Limitations

Our study has several limitations. Firstly, being a single-center and retrospective study, the diversity of patients and sample size could not be expanded. Secondly, due to the involvement of different bronchoscopists during the evaluation period, procedure durations varied according to the level of experience. Lastly, while intraoperative desaturation occurred, there is uncertainty regarding the rational documentation of these events.

## CONCLUSION

In conclusion, the majority of foreign body aspiration cases occur in male children under three years of age. The length of the procedure increases the likelihood of bronchospasm, independent of age and sex, and prolongs hospital stay. This study may contribute to the examination of pediatric bronchoscopy practices in larger sample groups through multicenter research and the comparison of the effectiveness of different anesthesia techniques, as well as the reassessment of clinical protocols for anesthesia management and procedure durations.

## ETHICAL DECLARATIONS

### Ethics Committee Approval

This study was approved by the Ethics Committee of Bozok University (Date: 06.03.2024, Decision No: GOKAEK-245_2024.06.05_76).

### Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

The authors declared that this study has received no financial support.

### Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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