



# How was Pediatric Flexible Bronchoscopy Implementation Affected During the COVID-19 Era? A Retrospective Study

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## ABSTRACT

**Aim:** As the application of flexible bronchoscopy (FB) has a high risk for infection transmission, it is recommended to postpone elective FB procedures during the coronavirus disease-2019 (COVID-19) pandemic. We aimed to determine how the COVID-19 pandemic affected pediatric FB implementation.

**Materials and Methods:** Medical records of patients who underwent FB from March 11, 2015, to September 11, 2020, were examined retrospectively. Records of the post-COVID-19 period (March 11, 2020, to September 11, 2020) were compared with records of pre-COVID-19 (consists of each six-month time window from March 11 to September 11 of each year from 2015 to 2019) period in terms of hospitalization status of the patients, with numbers and indications of FB. Some additional measures were taken during the FB procedure in the post-COVID-19 period. A number of health workers infected during FB procedures in the post-COVID-19 period were reviewed.

**Results:** Of the total of 182 procedures, the least FB was performed in the post-COVID-19 period (34, 30, 36, 36, 25, and 21 procedures respectively from 2015 to 2020). While microbiological sampling with bronchoalveolar lavage was the most common indication in the post-COVID-19 period, atelectasis was leading in the pre-COVID-19 period ( $p < 0.001$ ). In the post-COVID-19 period, most of the patients were inpatients while outpatient predominance was determined in the pre-COVID-19 period ( $p < 0.001$ ). None of the health workers was infected during the FB procedure.

**Conclusion:** Postponing elective FB procedures decreased the numbers and affected the indications of procedures during the COVID-19 era. Taking additional measures is of great importance and effective to prevent transmission of infection during FB.

**Keywords:** Childhood, COVID-19 pandemic, flexible bronchoscopy

## Introduction

In December 2019, a novel coronavirus identified in Wuhan, China led to a pandemic that quickly affected the whole of the world. World Health Organization named this illness coronavirus disease-2019 (COVID-19) on February 11, 2020, and then a global epidemic was declared on

March 11, 2020 (1,2). The first case in Turkey was officially proclaimed on March 11, 2020 (3). The main transmission route of the disease is respiratory droplets (4). Therefore, aerosol-generating procedures (AGP) are the most hazardous medical procedures for disease spread. While there are differences between health centers and countries

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Received: 28.10.2021 Accepted: 30.12.2021

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The Journal of Pediatric Research, published by Galenos Publishing House.

during the COVID-19 outbreak, these procedures have been recommended to be delayed if they are elective. With the prolongation of the epidemic period, more knowledge was obtained about the disease, and the effectiveness of the measures to prevent its spread during these procedures was investigated. Thus, elective interventions in many centers began to be implemented in the 'new normal' order. Flexible bronchoscopy (FB), one of these procedures, is one of the methods used for the diagnosis and/or treatment of childhood respiratory diseases (5,6).

In this study, we aimed to determine how the COVID-19 pandemic affected pediatric FB implementation in terms of hospitalization status of the patients, with numbers and indications of FB, and measures taken during FB procedure of pre-and post-COVID-19 periods.

## Materials and Methods

### Study Design

Medical records of patients who underwent FB in a tertiary hospital from March 11, 2015, to September 11, 2020, were examined retrospectively. Patients' age, gender, hospitalization status, and indications of FB were reviewed.

### Periods

Two study periods were formed according to the COVID-19 outbreak. The post-COVID-19 period is the period from March 11, 2020, to September 11, 2020, and the pre-COVID-19 period is the period from March 11, 2015, to March 10, 2020. To determine the characteristics of patients who underwent FB before the COVID-19 period, the procedures performed in the same months (March 11-September 11) of the 5 years before 2020 were retrospectively evaluated.

### Comparison of Pre-and Post-COVID-19 Periods

The hospitalization status of the patients and indications of FB were compared for pre-and post-COVID-19 periods.

### Flexible Bronchoscopy Procedure in the Pre-COVID-19 Period

Written informed consent was obtained from the parents of the patients in terms of the indications, purpose, reliability and possible complications of the procedure to be performed before bronchoscopy. Four hours of fasting for infants fed with breast milk only, four to six hours fasting for children between the ages of six months and three years, and six hours fasting for older children were required before the performance of the FB procedure. FB was performed in the operating room under general anesthesia with a team of bronchoscopists, assistant

doctors, nurses, and anesthesiologists. Routine anesthesia monitoring included pulse oximetry, capnography, temperature, three-lead electrocardiogram, and non-invasive blood pressure monitoring performed on the patients taken to the operating room during the process. The patients were orally administered midazolam (0.1 mg/kg) and paracetamol (10 mg/kg). General anesthesia was induced with propofol (2-3 mg/kg), ketamine (0.5 mg/kg), and in patients if the use of muscle relaxants is not contraindicated (evaluation of upper airway or laryngomalacia/tracheomalacia), rocuronium bromide (0.6 mg/kg) was used. During induction, first of all, three minutes of positive pressure ventilation with the mask was applied to the patient, followed by laryngeal mask airway (LMA) ventilation, and then, the patient received propofol infusion (100-200 mcg/kg/min) or sevoflurane (1-1.3 MAC) with oxygen 50-100%. At the end of the procedure, the neuromuscular blockage was reversed with sugammadex (2-4 mg/kg) if rocuronium was used during induction. While the bronchoscope with an outer diameter of 3.8 mm was used in patients whose body weights were  $\leq 15$  kg, the bronchoscope with an outer diameter of 4.8 mm was used in heavier patients. During the procedure, 0.5-1 mL lidocaine with saline solution was given at the level of the vocal cord and the main carina. Bronchoalveolar lavage (BAL) was performed in patients with suspected respiratory infection to determine the offending microbe and cases of suspected pulmonary hemosiderosis, aspiration pneumonia, pulmonary alveolar proteinosis, and in situ cases of unclear diagnosis, in addition to therapeutic use to rechannelize airways. BAL was accomplished with the use of normal saline warmed to body temperature. A 3 mL/kg volume was calculated and administered in three divided doses in children  $< 20$  kg. In children weighing  $\geq 20$  kg, 20 mL volumes were injected using a syringe via the suction channel of the bronchoscope. Approximately 40-70% of fluids were recovered by suction using a pressure of 25-100 mmHg as recommended by the European Society for Clinical Respiratory Physiology (7). Samples were separated from the BAL fluid for cytological examination and microbiological evaluation under sterile conditions.

### Measures were Taken During the FB Process During the Post-COVID-19 Period

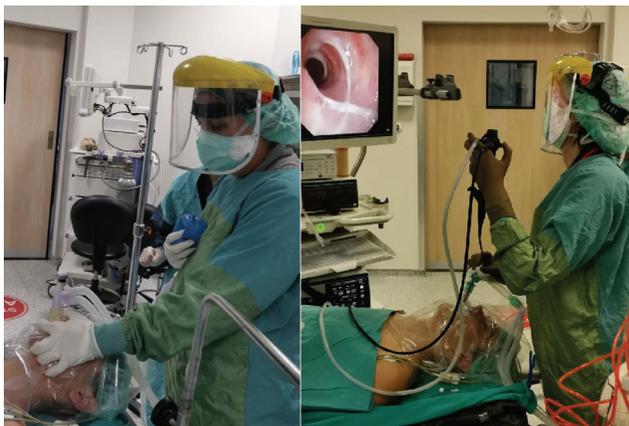
All patients who were scheduled to undergo FB were tested for COVID-19 via oropharyngeal swab, using the real-time polymerase chain reaction (PCR) method 24-48 hours before the procedure. Once the test was confirmed

negative, the patients were processed. At the same time, the COVID-19 contact of all patients was questioned. Even if the test result was negative, patients with known COVID-19 contact were not included in the process.

All procedures were performed in a negative pressure operating room. Before the patient was admitted to the room, all drugs and equipment were available. Premedication was done for reducing crying and aerosol generation if necessary. The patient was taken to the operation room with disposable sterile gowns and a surgical mask. All doors of the room were closed before the procedure. The number of health care workers (HCW) involved in the procedure was kept to a minimum. All HCW were required to have full personal protective equipment (PPE); a minimum of an N95 mask, isolation gown, head cover/hood, shoe covers, goggles/face shield, disposable sterile gowns, and gloves. All of the PPE we used during the process are presented in Figure 1. During the procedure, we avoided applying mask induction as much as possible. We preferred to perform FB via an LMA or endotracheal tube with minimal opening or disconnection of the ventilatory circuit to prevent the spread of aerosol. A clear plastic barrier was utilized over the LMA. If the patient needed intubation before or after the procedure, he/she was intubated using a cuffed intubation tube using a video laryngoscope. Between the two procedures, the room was ventilated for at least 20 minutes and all the materials that the patient had contact with were renewed.

#### Review of a Number of Health Workers Infected in the Post-COVID-19 Period During FB Procedures

A number of health workers infected in the post-COVID-19 period during FB procedures were reviewed.



**Figure 1.** The bronchoscopist and anesthesiologist who wore PPE are performing FB to a 14-year-old patient  
PPE: Personal protective equipment, FB: Flexible bronchoscopy

#### Statistical Analysis

SPSS 22.0 program was used to analyze the data. As descriptive, mean  $\pm$  standard deviation and median (minimum-maximum) were used for quantitative variables, and the number of patients (percentage) for qualitative variables. Chi-square and Fisher's exact tests were used to compare categorical variables between the groups. The statistical significance level was taken as 0.05.

Ethics committee approval was received for this study from the Ethics Committee of Ankara University (date: November 12, 2020; no: i9-593-20).

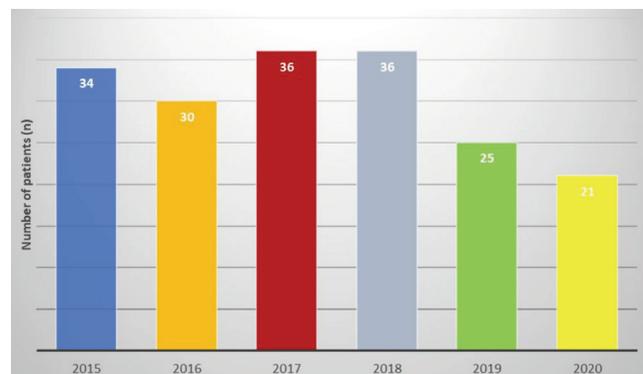
#### Results

##### Evaluation of All Patients Included in the Study

A total of 182 patients were included in the study. The distribution of the number of patients who underwent FB by years is presented in Figure 2. Ninety-three (51.1%) patients were male and 89 (48.9%) were female. The median age of the patients was 48 months (range, 1- 204 months). Eighty-two (45.0%) patients had chronic diseases. While 62 (34.2%) patients were hospitalized for another reason before FB, 120 (65.9%) patients were outpatients who applied for FB. Three most common indications for FB were atelectasis ( $n=39$ , 21.4%), chronic cough ( $n=32$ , 17.5%) and stridor ( $n=27$ , 14.8%). All of the indications with their frequencies are given in Table I. Diagnostic findings were detected in 146 (80.2%) of the patients. The findings are presented in Table II.

##### Comparison of Pre-and Post-COVID-19 Periods

The least FB was performed in post-COVID-19 period. When we evaluated the post-COVID-19 period, 9 (42.8%) patients were male. The median age of the patients was 30 months (range, 1.5-204 months). Seventeen (81%) patients were inpatient. The indications of FB performed in post-



**Figure 2.** Number of patients undergoing FB by years  
FB: Flexible bronchoscopy

COVID-19 period were microbiological sampling with BAL (n=6, 28.6%), extubation failure (n=4, 19.0%), atelectasis (n=3, 14.3%), stridor (n=2, 9.5%), persistent/recurrent pneumonia (n=1, 4.2%) and others (n=5, 23.8%).

One hundred and sixty-one (88.5%) underwent FB in pre-COVID-19 period. Eighty-four (52.1%) patients were male. The median age of patients was 49.5 months (range, 1-204 months). Sixty-two (38.5%) were inpatient. The indications of FB performed in pre-COVID-19 period were atelectasis (n=36, 22.3%), chronic cough (n=32, 19.8%), stridor (n=25, 15.5%), persistent/recurrent pneumonia (n=22, 13.6%), persistent/recurrent wheezing (n=15, 9.3%) extubation failure (n=3, 1.8%) and others (n=15, 9.3%).

While most of the patients in the post-COVID-19 period were inpatient, most of the patients in the pre-COVID-19 period were outpatient (p<0.001). There was also a statistically significant difference between the indications of FB in pre-and post-COVID-19 periods (p<0.001). Analysis

of qualitative variables for the pre-and post-COVID-19 period is given in Table III.

## Discussion

During the COVID-19 era, AGPs were the most affected among medical procedures due to their high risk for disease transmission. FB was also one of the risky procedures whose implementation had to decrease. In the post-COVID-19 period, we continued to apply FB without disease transmission to any HCW or patient with the measures we took in line with the information in the literature. When we compared the FB that were performed in pre and post COVID-19 periods, we found a statistical difference between the hospitalization status of patients and indications for FB.

Recommendations regarding the application of bronchoscopy during the COVID-19 period are presented as testing all patients before the procedure, postponing elective cases if possible, and taking the patient to the procedure after 2 weeks of strict isolation. Testing all patients for COVID-19 before the procedure is a recommendation given to detect asymptomatic patients (8). However, some asymptomatic patients may have false-negative results. Pre-analytical problems such as insufficient or inappropriate sampling, sample contamination, and analytical problems such as testing outside the diagnostic window, active viral recombination, use of poorly validated assays, device failure can be among the causes of false-negative results (9). Even if the patients to be processed are asymptomatic in an area where community transmission of COVID-19 infection is present, it is thought that the most important factor in preventing the spread of the disease is PPE. For this reason, it is recommended that PPE be worn by all HCW during the procedure, even if asymptomatic patients are tested before the procedure and found to be negative (10). We tested all patients we planned to undergo FB with or without COVID-19 disease symptoms using the PCR method. If the results were negative, we performed FB and continued the precautions during the procedure. Canadian Pediatric Anesthesia Society (11) recommended that all HCW should have appropriate PPE, all equipment must be ready before the patient's operative room is taken to shorten the procedure. It is also suggested to avoid mask induction during the procedure, performing all procedures in rooms with negative pressure if possible, and performing the patient's intubation with the help of a video-laryngoscope and by choosing a cuffed intubation tube. As aforementioned, we applied our FB processes with these recommendations in our center, and none of the HCWs were infected due to the FB procedure.

**Table I. Indications for flexible bronchoscopy of all patients**

Indications	n (%)
Atelectasis	39 (21.4)
Chronic cough	32 (17.5)
Stridor	27 (14.8)
Persistent/recurrent pneumonia	23 (12.6)
Microbiological sampling	20 (10.9)
Persistent/recurrent wheezing	15 (8.2)
Extubation failure	7 (3.8)
Others*	19 (10.9)

\*Other indications: Hemoptysis (n=8), localized air trapping (n=4), malignancy (n=2), evaluation before decannulation (n=2), interstitial lung disease (n=2), foreign body aspiration (n=1)

**Table II. Bronchoscopic findings of all patients**

Bronchoscopic findings	n (%)
Presence of purulent secretion suggesting active infection	46 (25.3)
Tracheo/bronchomalacia	46 (25.3)
Normal	36 (19.8)
Inferior airway anomalies (except tracheo/bronchomalacia)	18 (9.9)
Mucus plugging	16 (8.8)
Upper airway anomalies	14 (7.7)
Mucosal inflammation/laceration/granulation	9 (4.9)
Airway pressure	4 (2.2)
Foreign body aspiration	2 (1.1)

**Table III. Analysis of qualitative variables for pre- and post-COVID-19 period**

Variables		Post-COVID-19 period		Pre-COVID-19 period		p-value
		n	%	n	%	
<b>Hospitalization of patients</b>	Inpatient	17	81.0	45	28.0	<0.001 <sup>a</sup>
	Outpatient	4	19.0	116	72.0	
<b>Indications for FB</b>	Chronic cough	0	0.0	32	19.9	<0.001 <sup>b</sup>
	Atelectasis	3	14.3	36	22.4	
	Microbiological sampling	7	33.3	13	8.1	
	Persistent/recurrent pneumonia	1	4.8	22	13.7	
	Persistent/recurrent wheezing	0	0.0	15	9.3	
	Stridor	2	9.5	25	15.5	
	Extubation failure	4	19.0	3	1.9	
	Others	4	19.0	15	9.3	
<b>Diagnostic findings</b>	No	5	23.8	31	19.3	0.572 <sup>b</sup>
	Yes	16	76.2	130	80.7	

<sup>a</sup>Chi-square test, <sup>b</sup>Fisher's exact test  
COVID-19: Coronavirus disease-2019, FB: Flexible bronchoscopy

In the literature, there are studies presented by pediatric otorhinolaryngologists and surgeons, in which the measures were taken by the centers during the bronchoscopy procedures performed during the COVID-19 era (12-14). However, to the best of our knowledge, there is no study evaluating FB through the eyes of a pediatric pulmonologist in the COVID-19 era.

When we compared the hospitalization status of patients who underwent FB in the pre-and post-COVID-19 period, we found that statistically significantly more inpatients were performed in the post-COVID-19 period ( $p < 0.001$ ). We think that decrease in outpatient admissions during the pandemic period caused the admission of patients with an indication for FB to be delayed. We also found that there was a statistical difference between the indications for FB in the pre-and post-COVID-19 period ( $p < 0.001$ ). The most common indications we found in the pre-COVID-19 period are the most common indications for pediatric FB, previously presented in many studies and these indications are atelectasis, chronic cough, and stridor (15-18). On the other hand, we think that the reason we found the frequency of microbiological sampling and extubation failure indications increased in the post-COVID-19 period is that we mostly apply the procedure among hospitalized patients. All four patients in whom we performed FB due to extubation failure were patients who were undergoing intensive care follow-up after an operation for congenital heart disease. Performing FB could not be delayed for withdrawal of respiratory support and discharge of these patients. Treatment of patients who underwent bronchoscopy due to microbiological sampling was adjusted with the microbiological data obtained. These

examples allow us to predict that delaying FB procedure in children, even during the COVID-19 period, will have a negative effect on the morbidity and/or mortality of the patients.

The most important limitation of our study is that the number of procedures we performed in the post-COVID-19 period is much less compared to the other group. The purpose of our evaluation of the last 5 years before COVID-19 was to ensure the homogeneity of the data of previous years.

### Conclusion

COVID-19 pandemic era has led to drawbacks in the application of pediatric FB, as the other AGP. Postponing elective FB procedures decreased the numbers and affected the indications of procedures in our center during the COVID-19 era. Taking additional measures is effective to prevent the transmission of infection during FB. Therefore, pediatric pulmonologists must continue to do FB, despite having to deal with AGP, in the 'new normal'. With the 'new normal', pediatric FB should be continued with pre-procedure contact/symptom questioning, PCR testing, and full use of PPE.

### Ethics

**Ethics Committee Approval:** Ethics committee approval was received for this study from the Ethics Committee of Ankara University (date: November 12, 2020; No: i9-593-20).

**Informed Consent:** Written informed consent was obtained from the parents of the patients in terms of the indications, purpose, reliability and possible complications of the procedure to be performed before bronchoscopy.

**Peer-review:** Externally peer-reviewed.

### Authorship Contributions

Data Collection or Processing: G.Ö., F.Z., M.N.T., Analysis or Interpretation: G.Ö., B.B., Literature Search: Ö.S.C., N.Ç., Writing: G.Ö.

**Conflict of Interest:** The authors declare that they have no conflict of interest.

**Financial Disclosure:** The authors declared that this study received no financial support.

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