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Analysis of 332 fiberoptic bronchoscopies performed in a respiratory intensive care unit: a retrospective study

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Abstract. – OBJECTIVE: Fiberoptic bronchoscopy (FOB) is widely used in the intensive care unit for diagnostic and therapeutic purposes. Our study aimed to evaluate FOB's indications, complications, and clinical outcomes in our intensive care unit's mechanically ventilated patients and identify the microorganisms grown in bronchoalveolar lavage (BAL) specimens.

PATIENTS AND METHODS: Between January 1, 2022, and June 30, 2023, a total of 332 FOBs were performed on 178 patients in the respiratory intensive care unit.

RESULTS: Patients' mean age was 64±19.4 years. Females accounted for 65 (36.6%) and males accounted for 113 (63.4%) of the cases. Leading diagnoses included pneumonia (59.5%), acute respiratory distress syndrome (ARDS) (20.7%), sepsis (17.9%), chronic obstructive pulmonary disease (COPD) attack (21.9%), pulmonary embolism (10.1%), lung malignancy (43.8%), hemoptysis (8.9%), heart failure (15.1%), neurological/neuromuscular conditions (8.4%), and post cardiopulmonary resuscitation (CPR) (2.8%). FOB purposes were BAL retrieval (43.6%), secretion clearance (30.4%), guided tracheostomy (11.7%), atelectasis (8.7%), and hemoptysis (5.4%). Hypoxemia marked the primary FOB complication (3.6%). Other issues encompassed hypotension (1.5%), bradycardia (1.2%), bleeding (1.2%), tachycardia (0.9%), and hypertension (0.6%). No statistical significance was found in arterial blood gas pH, arterial partial pressure of oxygen (PaO_2), and arterial partial pressure of carbon dioxide ($PaCO_2$) values before and after the FOB procedure ($p>0.05$). Predominant pathogens in aspiration samples were *non-albicans Candida* (28.9%), *Klebsiella pneumoniae* (24.8%), *Pseudomonas aeruginosa* (14.4%), and *Acinetobacter baumannii* (11.7%).

CONCLUSIONS: FOB is an important diagnostic and therapeutic method with a low complication rate when performed by an experienced team with appropriate indication in the intensive care unit.

Key Words:
Fiberoptic bronchoscopy (FOB), Intensive care units, Bronchoalveolar lavage (BAL).

Introduction

Fiberoptic bronchoscopy (FOB) is a minimally invasive procedure employed to examine the airways and lungs visually. It involves the insertion of a slender, flexible tube equipped with a camera at its tip, either through the nose or the mouth. This technique was first used in 1967 and is now widely utilized in intensive care units due to its low complication rate. In this setting, FOB serves various purposes, including illustrating airway blockage, facilitating secretion clearance, conducting bronchoalveolar lavage (BAL), identifying the cause of hemoptysis, as well as detecting malignancies, and performing biopsies. FOB encompasses therapeutic procedures like aspirating bronchial secretions, extracting mucus plugs that lead to atelectasis, and managing bleeding in cases of hemoptysis[2,3]. Notably, its application is considered safer in intubated patients within the intensive care unit as opposed to non-intubated patients. Nevertheless, it is important to note that, akin to other medical interventions and treatments, complications like pneumothorax, hypoxemia, hypercapnia, arrhythmia, bleeding, fever, and infection may arise during and after the procedure[4]. Utilizing FOB through an endotracheal tube offers distinct advantages. This approach enables more efficient administration of supplemental oxygen therapy throughout the procedure and is conveniently deployable at the patient's bedside. Consequently, its prevalence for diagnostic and therapeutic purposes in intensive care units is on a steady rise[3].

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Our study aimed to evaluate FOB's indications, complications, and clinical outcomes in our intensive care unit's mechanically ventilated patients and identify the microorganisms grown in bronchoalveolar lavage specimens.

Patients and Methods

Our retrospective study involved examining data from patients under care in our hospital's respiratory intensive care unit between January 1, 2022, and June 30, 2023. Those for whom data retrieval proved unattainable were excluded from the study. Information regarding patients who underwent FOB was sourced from our hospital's data system. Parameters such as age, gender, the reason for admission to the intensive care unit, indications for FOB, FOB findings, microorganisms isolated from bronchoalveolar lavage (BAL), FOB-related complications, as well as pH, arterial partial pressure of oxygen (PaO_2), and arterial partial pressure of carbon dioxide ($PaCO_2$) values in blood gas both before and after FOB, were meticulously recorded.

Within our intensive care unit, the procedure is abstained from in the presence of any contraindications identified during pre-FOB assessments. These contraindications comprise severe hypoxemia, hemodynamic instability persisting despite the administration of vasoactive drugs, acute cardiac ischemia, and uncontrolled cardiac arrhythmias.

The procedure is performed with FOB (FUJIFILM Corporation/EB-530T 1B084K431, Japan) in our intensive care unit in mechanically ventilated patients. In mechanically ventilated patients, a fraction of inspired oxygen (FiO_2) was increased to 100% 20 minutes before FOB. The current positive end-expiratory pressure (PEEP) value was kept at or below 5 mmHg to avoid high pressure in the lung. Before the procedure, midazolam (0.1 mg/kg) and fentanyl (0.5 µg/kg) were given IV for sedation. Propofol (1-2 mg/kg) and rocuronium (0.2-0.3 mg/kg) IV were also used in some patients. An apparatus (catheter mount) with a small hole in the center was placed at the end of the endotracheal tube or tracheostomy cannula tip to allow FOB to pass through. The endotracheal tube or tracheostomy cannula was evaluated by entering with FOB, and then FOB was advanced from the tracheobronchial tree to the carina. The mouths of the right and left main bronchi were examined, and then the distal airways were evaluated.

Ethics committee approval (Date-decision No.: 10.11.2022/ 2022-294) was obtained for the study at Health Sciences University Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital. The study was conducted following the Declaration of Helsinki.

Statistical Analysis

The demographic and clinical data of the patients and descriptive statistics and quantitative data were expressed as mean ± standard deviation (SD) to show the relationship between categorical data, while qualitative data were expressed as numbers and percentages (%). The conformity of the data to normal distribution was evaluated by the Shapiro-Wilk normality test. Student's *t*-test was used to test the significance of the difference between normally distributed quantitative variables. In the study, p-value <0.05 was accepted as significant. SPSS program version 22 (IBM Corp., Armonk, NY, USA) was used for calculations.

Results

Our study included 178 patients hospitalized in the intensive care unit, followed up on a mechanical ventilator, and underwent FOB 332 times in total. The mean age of the patients was 64±19.4 years. The number of female patients was 65 (36.6%) and the number of male patients was 113 (63.4%) (Table I).

When the diagnoses of intensive care unit hospitalization were examined, it was found that the majority of the patients had pneumonia (59.5%), acute respiratory distress syndrome (ARDS) (20.7%), sepsis (17.9%), chronic obstructive pulmonary disease (COPD) attack (21.9%), pulmonary embolism (10.1%), lung malignancy (43.8%), hemoptysis (8.9%), heart failure (15.1%), neurological/neuromuscular disease (8.4%) and post cardiopulmonary resuscitation (CPR) (2.8%) (Table I).

A total of 332 fiberoptic bronchoscopy (FOB) procedures were performed. The distribution of these procedures is presented in Table I.

The indications for FOB were as follows: a microbiologic sampling of the respiratory tract by bronchoalveolar lavage at 43.6%, secretion clearance at 30.4%, FOB-guided percutaneous tracheostomy at 11.7%, atelectasis 8.7%, and hemoptysis 5.4% (Table II).

The most common complication during FOB was hypoxemia (3.6%). Other complications were hypotension (1.5%), bradycardia (1.2%), bleed-

Table I. Patients' demographic characteristics.

Age (year) (mean ± SD)	64 ± 19.4	
Gender	**N (%)**	
Female	65 (36.6%)	
Male	113 (63.4%)	
Intensive care hospitalization diagnoses	**N**	**%**
Pneumonia	106	59.5
ARDS	37	20.7
Sepsis	32	17.9
COPD attack	39	21.9
Pulmonary embolism	18	10.1
Lung malignancy	78	43.8
Hemoptysis	16	8.9
Heart failure	27	15.1
Neurological/neuromuscular disease	15	8.4
Post CPR	5	2.8
Prognosis	**N (%)**	
Exitus	110 (61.79%)	
Discharged	68 (38.21%)	
The total number of FOBs performed was 332 95 patients performed one time 52 patients performed two times 31 patients performed three times 10 patients performed three or more times		

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPR: Cardiopulmonary resuscitation, SD: Standard deviation, n: Number of patients, %: Percentage.

ing (1.2%), tachycardia (0.9%), and hypertension (0.6%) (Table II).

No statistically significant difference was found in pH, PaO_2, and $PaCO_2$ values in arterial blood gas before and after the FOB procedure (p>0.05) (Table III).

The most common pathogens isolated from aspiration material by FOB were *non-albicans Candida* (28.9%), followed by *Klebsiella pneumoniae* (24.8%), *Pseudomonas aeruginosa* (14.4%), *Acinetobacter baumannii* (11.7%). Other isolated pathogens are presented in Table IV.

Discussion

FOB is used for both diagnosis and treatment in the intensive care unit. Olopade and Prakash[5] performed 198 procedures on 129 patients, 44% for diagnosis, 47% for treatment, and 9% for both diagnosis and treatment. In our study, 43% of FOB procedures were performed for diagnosis, 30% for treatment, and 27% for both diagnosis and treatment.

In the study by Hasegawa et al[6], 27% of FOB procedures were conducted for atelectasis and secretion clearance, while 8% focused on addressing hemoptysis. Another study[7] reported that 14.5% of FOB interventions were for atelectasis, 4.1% for bleeding, and 3.1% for secretion clearance. Kaparianos et al's[8] study revealed that 21% of FOB procedures were performed for hemoptysis and 5.8% for atelectasis. In our own study, 30.4% of FOB procedures were dedicated to secretion clearance, 8.7% to atelectasis, and 5.4% to hemoptysis.

In the study conducted by Snow and Lucas[9], an enhancement in chest radiography was noted in 31 out of 35 patients (89%) following FOB procedures aimed at treating atelectasis. In the study by Stevens et al[10], atelectatic areas improved in 93 of 118 patients. In another study[5], 19% of the patients who underwent FOB had improved atelectatic chest radiography and improved oxygenation. In our own study, we observed an improvement in chest radiography in 25 out of 29 patients (86%) following FOB interventions for atelectasis.

It is well-documented that complications, including bradycardia, tachycardia, hypotension, hypertension, hypoxemia, and bleeding, may manifest during FOB procedures[11,12]. In the study conducted by Turner et al[13], hypoxemia occurred in 29 of 107 patients, bleeding occurred in 2, and tachycardia occurred in 1. In another study[14], hypoxemia was noted in 4.2% of cases, tachycardia/

Table II. FOB indications and complications.

	N	%
FOB indications		
Hemoptysis	18	5.4
Secretion cleansing	101	30.4
Bronchoalveolar lavage/Microbiologic sampling from respiratory tract	145	43.6
Percutaneous tracheostomy opening with FOB	39	11.7
Atelectasis	29	8.7
FOB complications		
Hypoxemia	12	3.6
Bradycardia	4	1.2
Tachycardia	3	0.9
Hypotension	5	1.5
Hypertension	2	0.6
Bleeding	4	1.2

FOB: Fiberoptic bronchoscopy, N: Number of patients, %: Percentage.

Table III. pH, PaO_2, and $PaCO_2$ values before and after FOB.

	Before FOB mean ± SD	After FOB mean ± SD	*p*-value
pH	7.44 ±0.05	7.43±0.06	0.084
PaO_2	82.3±28.7	84.6±30.4	0.079
$PaCO_2$	41.5±10.5	40.2±8.9	0.081

FOB: Fiberoptic bronchoscopy, PaO_2: Arterial partial pressure of oxygen, $PaCO_2$: Arterial partial pressure of carbon dioxide, SD: Standard deviation.

bradycardia in 2.5%, hypotension/hypertension in 1.7%, and bleeding in 2.5%. Our study observed hypoxemia in 3.6% of cases, bradycardia in 1.2%, tachycardia in 0.9%, hypotension in 1.5%, hypertension in 0.6%, and bleeding in 1.2%.

In the study conducted by Orhan et al[15], it was noted that the PaO_2 value exhibited a noteworthy increase following FOB. Conversely, in another study[14], although there was no disparity in pH values prior to FOB, a significant rise in PaO_2 and a notable decline in $PaCO_2$ were observed post-procedure. Álvarez-Maldonado et al[16], on the other hand, reported no substantial alteration in PaO_2 values before and after FOB. Our study observed no significant discrepancies in pH, PaO_2, or $PaCO_2$ values following FOB.

Another indication for FOB is taking culture with BAL. In intensive care unit patients in whom the pathogen causing pneumonia cannot be produced in deep tracheal aspirate, taking a BAL sample obtained from pulmonary secretions is a safe and diagnostically efficient method[17]. In our study, BAL was obtained with FOB at different times from 106 patients hospitalized with a diagnosis of pneumonia and contributed to the regulation of antibiotics.

In the study by Başarık et al[18] the agents isolated from bronchoscopic aspiration material were *Candida albicans* 39 (38.2%), *non-albicans Candida* species 11 (10.7%), and *Acinetobacter baumannii* 8 (7,8%), while the agents isolated from BAL material were *Candida albicans* 23 (22.5%), *non-albicans Candida* species 25 (24.5%), *Acinetobacter baumannii* 6 (5.8%) and *Pneumocystis jirovecii* 6 (5.8%). In another study[19], the most common pathogens isolated from BAL were *Acinetobacter baumannii* 15 (35%), *Pseudomonas aeruginosa* 7 (16%), *Klebsiella pneumoniae* 5 (12%), *Escherichia coli* 5 (12%). In Orhan et al[15] study, pneumonia-causing bacteria were isolated in 14 (46.7%) patients with BAL sampling. These were *Acinetobacter baumannii* 3 (21.4%), *Klebsiella pneumoniae* 4 (28.6%), and *Pseudomonas aeruginosa* 7 (50%). In our study, the pathogens isolated from aspiration material by FOB were *non-albicans Candida* (*Candida auris, Candida glabrata, Candida parapsilosis, Candida dubliniensis, Candida tropicalis*) 28.9%, *Candida albicans* 11%, *Klebsiella pneumoniae* 24.8%, *Pseudomonas aeruginosa* 14.4%, *Acinetobacter baumannii* 11.7%, *Escherichia coli* 1.3%.

The use of FOB during percutaneous dilatational tracheostomy in an intensive care unit provides benefits such as demonstrating the site of needle entry into the trachea, accurate guidewire advancement, monitoring the dilated tracheal area, and rechecking the airway after tracheostomy cannula placement[20]. In the study of Topcu et al[21], minor bleeding was observed in 4 patients, major bleeding in 11 patients, hypoxemia in 7 patients and pneumothorax in 1 patient in 44 percutaneous dilatational tracheostomies performed using the anatomical landmark technique. In our

Table IV. Pathogen isolated from aspiration material by FOB.

	N	%
Pseudomonas aeruginosa	21	14.4
Acinetobacter baumannii	17	11.7
Klebsiella pneumoniae	36	24.8
Escherichia coli	2	1.3
Staphylococcus aureus	1	0.6
Haemophilus influenza	1	0.6
Stenotrophomonas maltophilia	2	1.3
Enterobacter aerogenes	7	4.8
Proteus mirabilis	3	2.0
Cryptococcus laurentii	6	4.1
Candida albicans	16	11.0
Non-albicans Candida (Candida auris, Candida glabrata, Candida parapsilosis, Candida dubliniensis, Candida tropicalis)	42	28.9

FOB: Fiberoptic bronchoscopy, N: Number of patients, %: Percentage.

study, 39 patients underwent percutaneous tracheostomy with FOB, and no complications developed.

Limitations

It is important to note that our study has some significant limitations. Specifically, we conducted the study at a single center and used a retrospective design.

Conclusions

Our study shows that FOB in the intensive care unit still remains an important and effective procedure with low complication rates. Furthermore, our study revealed that a specialist trained in FOB can effectively perform most FOB procedures that may be required to diagnose and treat patients in the intensive care unit.

Conflict of Interest

The authors declare that they have no conflict of interests.

Ethics Approval

Ethics committee approval was obtained for the study at Health Sciences University Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital. Date/No. of approval: 10.11.2022/ 2022-294.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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Authors' Contributions

The concept for research or article/hypothesis generation: Kamuran Uluç, Esra Akkütük Öngel, Şükran Merve Çolakoğlu, Özkan Devran. Planning the methods to generate the hypothesis: Kamuran Uluç, Esra Akkütük Öngel, Şükran Merve Çolakoğlu, Nazan Köylü İlkaya. Supervision and responsibility for the organization and course of the project and manuscript preparation: Kamuran Uluç, Esra Akkütük Öngel, Şükran Merve Çolakoğlu, Hatice Kutbay Özçelik. Supplying equipment, space, and personnel vital to the Project: Kamuran Uluç, Şükran Merve Çolakoğlu, Özkan Devran. Discussion of the results and approval of the final version of the work: Kamuran Uluç, Nazan Köylü İlkaya, Hatice Kutbay Özçelik.

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Data Availability

The data generated and analyzed during the study are available from the corresponding author. They are not available publicly.

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