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# Indications and findings of flexible bronchoscopy in trauma field in Korea: a case series

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**Purpose:** Since its implementation, flexible fiberoptic bronchoscopy (FBS) has played an important role in the diagnosis and treatment of tracheobronchial tree and pulmonary disease. Although FBS is often performed by endoscopists, it has also been performed by surgeons, albeit rarely. This study investigated FBS from the surgeon's perspective.

**Methods:** This retrospective study included patients who underwent FBS performed by a single thoracic surgeon between March 2017 and December 2021. Accordingly, the epidemiology, purpose, results, and complications of FBS were analyzed.

**Results:** A total of 47 patients received FBS, whereas 13 patients underwent repeat FBS. Their mean age was 60.7 years. The main organs injured involved the chest (n=22), brain (n=9), abdominal organ (n=7), cervical spine (n=4), extremities (n=4), and face (n=1). The average Injury Severity Score was 22.5. Indications for FBS included atelectasis or haziness on chest x-ray (n=34), pneumonia (n=17), difficult ventilator management (n=7), percutaneous dilatory tracheostomy (n=3), blood aspiration (n=2), foreign body removal (n=2), and intubation due to a difficult airway (n=1). The findings of FBS were mucous plugs (n=36), blood and blood clots (n=16), percutaneous dilatory tracheostomy (n=3), foreign bodies (n=2), granulation tissue at the tracheostomy site (n=2), tracheostomy tube malposition (n=1), bronchus spasm (n=1), difficult airway intubation (n=1), and negative findings (n=5). None of the patients developed complications.

**Conclusions:** FBS is an important modality in the trauma field that allows for the possibility of diagnosis and therapy. With sufficient practice, surgeons may safely perform FBS at the bedside with relative ease.

**Keywords:** Bronchoscopy; Intratracheal intubation; Mechanical ventilators; Pulmonary atelectasis; Tracheostomy

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## INTRODUCTION

### Background

Blunt trunk trauma has occasionally been associated with lung parenchymal and bronchial injuries. Intrabronchial bleeding or aspiration, as evidenced by blood-tinged sputum, can lead to bronchial occlusion and atelectasis [1]. In cases requiring long-term mechanical ventilator care or having severe neurologic inju-

ry involving the brain, pulmonary complications, such as pneumonia and atelectasis, could occur because of the inability to perform voluntary sputum expectoration. These pulmonary complications often lead to devastating results. As such, the early detection of lung parenchymal or bronchial injury is beneficial to patients as they allow for prompt treatment. Moreover, resolving atelectasis or detecting pneumonia-causing bacteria at an early stage is helpful for patients receiving long-term ventilation therapy.

Since its the implementation by Ikeda et al. [2], flexible fiberoptic bronchoscopy (FBS) has played an important role in the diagnosis and treatment of tracheobronchial tree and pulmonary diseases, given that it is relatively easy to learn and use, can be used with topical anesthesia and minimal sedation, and rarely causes serious complications. Although FBS is often performed by an endoscopist, surgeons have also performed it, albeit rarely.

### Objectives

This study investigated FBS from the surgeon's perspective in the trauma field, in an attempt to identify the usefulness and complications of FBS in trauma patients.

## METHODS

### Ethics statement

This study was approved by the Ethics Committee of Dankook University Hospital (No. 2022-06-046-002). The requirement for informed consent was waived due the retrospective nature of the study.

### Study design and participants

This is a case series by one surgeon in two institutes. From March 2017 to December 2021, patients who underwent FBS (BF-P260F Bronchoscope, Olympus Medical Systems Corp) by a single thoracic surgeon at Dankook University Hospital (Cheonan, Korea) and Daejeon Eulji Medical Center (Daejeon, Korea) for multiple trauma were enrolled in this retrospective study, and the epidemiology, purpose, results, and complications of FBS were analyzed. All medical records were reviewed.

### Study setting and procedures

Indications for FBS included abnormal findings on chest x-rays or chest computed tomography, unexplained hypoxemia, and procedures for the trachea or bronchi. During FBS, oxygen saturation, electrocardiogram readings, and blood pressure were monitored. FBS was performed under a fraction of inspired oxygen of 100% and volume control (60 mL/kg), with a positive end-expiratory pressure of 10 mmHg in patients undergoing mechanical ventilation. Midazolam was administered intravenously for general anesthesia with spontaneous breathing or complete loss of consciousness. Intravenous atropine (0.01–0.02 mg/kg) was administered for bradycardia induced by vagal stimulation. Topical anesthesia was achieved by using lidocaine spray. Muscle relaxants were occasionally administered in patients undergoing mechanical ventilation.

### Statistical analysis

Descriptive statistics are expressed as the mean ± standard deviation unless otherwise specified.

## RESULTS

A total of 47 patients received FBS, whereas 13 patients underwent repeat FBS. The total number of FBS procedures was 68, and the number of repeat FBS was 33. The patients had a mean age of 60.7 years. The main organs injured were the chest (n = 22), brain (n = 9), abdominal organ (n = 7), cervical spine (n = 4), extremities (n = 4), and face (n = 1). The average Injury Severity Score was 22.5 (Table 1). All patients except one received endotracheal intubation and mechanical ventilator care.

The purpose of FBS was atelectasis or haziness on chest x-ray (n = 34), pneumonia (n = 17), difficult ventilator management (n = 7), percutaneous dilatory tracheostomy (n = 3), blood aspiration (n = 2), foreign body removal (n = 2), and intubation due to a difficult airway (n = 1) (Table 2). The patient who received intubation due to a difficult airway was the same patient who did not receive mechanical ventilator care. The findings of FBS were mucous plugs (n = 36), blood and blood clots (n = 16), percutaneous

**Table 1.** Patient characteristics (n=47)

| Characteristic | Value |
|---|---|
| Age (yr) | 60.7±17.4 |
| Sex | |
| Male | 38 |
| Female | 9 |
| Injured organ | |
| Chest | 22 |
| Brain | 9 |
| Abdomen | 7 |
| Spine | 4 |
| Extremity | 4 |
| Face | 1 |
| Injury Severity Score | 22.5±9.6 |

Values are presented as mean±standard deviation or number only.

**Table 2.** Purposes of flexible fiberoptic bronchoscope (n=47)

| Purpose | No. of patients |
|---|---|
| Atelectasis or hazziness on chest x-ray | 34 |
| Pneumonia | 17 |
| Difficult ventilator manage | 7 |
| Percutaneous tracheostomy | 3 |
| Blood aspiration | 2 |
| Foreign body removal | 2 |
| Difficult airway intubation | 1 |

**Table 3.** Findings of flexible fiberoptic bronchoscope

| Outcome | No. of patients |
|---|---|
| Removal of mucous plug | 36 |
| Blood aspiration | 16 |
| Percutaneous tracheostomy | 3 |
| Foreign body removal | 2 |
| Granulation tissue at tracheostomy site | 2 |
| Tracheostomy tube malposition | 1 |
| Bronchus spasm | 1 |
| Difficult airway intubation | 1 |
| Negative findings | 5 |

dilatory tracheostomy (n = 3), foreign bodies (n = 2), granulation tissue at the tracheostomy site (n = 2), tracheostomy tube malposition (n = 1), bronchus spasm (n = 1), difficult airway intubation (n = 1), and negative findings (n = 5) (Table 3). The reasons for repeated FBS were pneumonia (n = 12), atelectasis (n = 4), and percutaneous dilatory tracheostomy (n = 1). None of the patients developed complications.

## DISCUSSION

This study found that airway maintenance was an important purpose of FBS in the trauma field. In this study, FBS was performed mainly because a majority of the patients received ventilator care. The findings of FBS can be categorized into clearance and securing the airway. With regard to clearance, materials removed during FBS included mucous plugs, blood, and foreign bodies. With regard to securing the airway, percutaneous tracheostomy and difficult airway intubation were observed.

Blunt trunk trauma has been associated with lung parenchymal and bronchial injuries. In such cases, blood-tinged sputum was present, and intrabronchial bleeding and aspiration promoted bronchial occlusion and atelectasis [1]. The ultimate goal of FBS was the restoration of airway patency by removing phlegm or blood in the airway [3]. In study, the main reasons for FBS included atelectasis or haziness on chest x-ray and pneumonia. The primary findings of FBS were mucous plugs and blood aspiration. Furthermore, the reasons for repeated FBS were pneumonia and atelectasis. The main bronchoscopy findings in acute trauma to the chest and upper airway were distal hemorrhage/pulmonary contusion and mucous plugs/ thick secretions [4]. Most mucous plugging can be removed through FBS [3]. By removing blood, mucous plugs, and aspirated fluid, the medium for bacterial growth could be reduced [1]. Bronchoscopy after blunt thoracic trauma could help establish an early diagnosis of lung contusion and provide information on the respiratory prognosis of these patients [1].

FBS has a channel for irrigation and endoscopic forceps, which allows for the removal of foreign bodies in the airway. In this study, two cases required foreign body removal. One case involved the aspiration of a bone fragment from a fractured mandible after the patient fell on the face, whereas the other case involved the aspiration of dust and soil after being buried in the mud following a traffic accident. The best option for removing foreign bodies in the trachea and bronchus is rigid bronchoscopy [5]. In these two cases, the patients received mechanical ventilator care for acute respiratory failure. Given that rigid bronchoscopy was dangerous for these patients, foreign body removal was done through FBS, which was indeed completely successful.

Percutaneous tracheostomy using the dilation technique under FBS assistance would be effective and safe in preventing serious complications or deaths in critical care patients under mechanical ventilation [6]. In our study, three percutaneous tracheostomies were performed. Two surgeons were required for percutaneous tracheostomy under FBS. One thoracic surgeon performed tracheostomy using the dilator (Cook Blue Rhino single dilator kit, Cook Medical), whereas another thoracic surgeon observed the trachea through FBS. The safe placement of the needle and guidewire was achieved through FBS. None of the patients developed early complications, such as bleeding, transient hypoxia, or tracheostomy cannula displacement. Long-term monitoring was required to assess late complications, such as bronchomalacia, tracheoesophageal fistulas, or tracheoinnominate fistulas. Although studies have found no advantage of percutaneous tracheostomy under FBS [7], evidence has shown that it lowers the possibility of iatrogenic damage to surrounding tissues [8].

In our study, one patient had difficult airway intubation with FBS due to limitations in mouth opening related to facial bone fractures. FBS provides direct visualization of the airway structures. Indications for flexible bronchoscopic intubation include limited mouth opening; short thyromental distance; macroglos-


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sia; obesity; airway compromised by infection, tumor, or edema; inability to extend the neck or cervical instability; fragile or protruding teeth; and patients with Mallampati class III to IV [9].

FBS is a safe procedure, with a mortality rate under 0.04% and a major complication rate between 0.08% and 0.3% [10]. Major complications include death, cardiopulmonary arrest, myocardial infarction, pneumonia, large-sized pneumothorax, severe airways obstruction, severe pulmonary hemorrhage, seizures, and stroke [10]. In our study, none of the patients developed such complications or died.

FBS offers some advantages over rigid bronchoscopy. Its flexibility allows for better examination of the distal airways and upper lobe segment and can be introduced through an endotracheal tube or tracheostomy, allowing for the evaluation of tube placement and bronchoscopic intubation [11]. FBS has been most useful in the evaluation of patients with atelectasis or a suspected foreign body for which there was insufficient evidence to warrant open-tube bronchoscopy and for those with tracheostomies [12]. FBS plays an essential role in the diagnosis and treatment of patients under ventilator care [13,14].

### Limitations

This study had several limitations. First, this study included a heterogeneous group of patients. Second, the number of patients was only 47. Therefore, further studies with a larger population seem necessary. However, our data highlight the effectiveness of FBS performed by trauma surgeon in the trauma field.

### Conclusions

FBS is an important procedure in the trauma field that allows for the possibility of diagnosis and therapy. With sufficient practice, FBS can be performed with relative ease and safety by surgeons at the bedside.

## ARTICLE INFORMATION

### Conflicts of interest

The author has no conflicts of interest to declare.

### Funding

The author did not receive any financial support for this study.

### Data availability

Data of this study are available from the author upon reasonable request.

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