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Original Research Article

UTILITY OF FIBEROPTIC BRONCHOSCOPY FOR RESPIRATORY ISSUES IN THE MULTISPECIALTY INTENSIVE CARE UNITS

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ABSTRACT

Background: Respiratory complications such as lung atelectasis are common in critically ill patients and contribute to prolonged mechanical ventilation and ICU stay. Flexible fiberoptic bronchoscopy offers both diagnostic and therapeutic benefits in this population. The objective is to evaluate the radiographic response and therapeutic effectiveness of flexible fiberoptic bronchoscopy in ICU patients with lung atelectasis.

Materials and Methods: A prospective observational study was conducted in 77 ICU patients undergoing bronchoscopy for respiratory complications. Chest radiographs were assessed before bronchoscopy and at 6 and 24 hours post-procedure to evaluate lung re-expansion.

Results: Lobar collapse was the most common initial radiographic finding. Significant radiographic improvement was observed at 6 hours, with further increase in complete lung re-expansion at 24 hours following bronchoscopy.

Conclusion: Flexible fiberoptic bronchoscopy is an effective and safe therapeutic intervention for lung atelectasis in critically ill patients, resulting in significant and sustained radiographic improvement.

Keywords: Fiberoptic bronchoscopy, Atelectasis, Intensive care unit, Lung re-expansion.

INTRODUCTION

Flexible fiberoptic bronchoscopy (FOB) has become an indispensable diagnostic and therapeutic modality in the management of critically ill patients with respiratory complications admitted to intensive care units (ICUs). The procedure allows direct visualization of the tracheobronchial tree and facilitates identification of airway abnormalities, endobronchial lesions, secretions, and foreign material, while simultaneously enabling diagnostic sampling and therapeutic interventions.[1,2] Its minimally invasive nature and ability to be performed at the bedside make FOB particularly valuable in critically ill patients who may not tolerate transportation for radiological or surgical procedures.[3]

In ICU settings, FOB is frequently employed for a wide range of indications including persistent or unexplained atelectasis, non-resolving pneumonia, hemoptysis, suspected airway obstruction, and unexplained respiratory deterioration.[4,5] Several studies have demonstrated that FOB has a high diagnostic yield in such scenarios and often leads to modification of clinical management, especially when conventional imaging and noninvasive diagnostic methods fail to provide definitive information.[6] In mechanically ventilated patients, FOB plays a crucial role in evaluating airway patency, secretion burden, and tube positioning, thereby aiding in optimization of ventilatory strategies.[7]

Beyond direct visualization, the diagnostic utility of FOB is significantly enhanced by bronchoalveolar lavage (BAL), which allows retrieval of lower respiratory tract samples for microbiological, cytological, and immunological analysis.[8] BAL-guided microbiological diagnosis has been shown to improve pathogen identification, facilitate early de-escalation or escalation of antimicrobial therapy, and reduce inappropriate antibiotic exposure, particularly in immunocompromised and ventilated patients.[9] Recent ICU-based studies report culture positivity rates exceeding 50% following FOB-

guided sampling, highlighting its value in guiding targeted antimicrobial therapy and improving therapeutic outcomes.[6,8]

FOB also serves an important therapeutic role in critically ill patients by enabling removal of mucus plugs, bronchial toileting, and resolution of lobar or segmental collapse, leading to improved lung aeration, oxygenation, and respiratory mechanics.[3,7] These therapeutic interventions are especially beneficial in patients with prolonged mechanical ventilation, neuromuscular weakness, or impaired cough reflex, where secretion clearance is compromised.[5]

Although FOB is generally considered a safe procedure, critically ill patients present unique challenges due to hemodynamic instability, hypoxemia, mechanical ventilation, and multisystem involvement. Procedure-related complications such as transient hypoxemia, minor airway bleeding, arrhythmias, or hemodynamic fluctuations have been reported; however, major adverse events remain uncommon when FOB is performed by experienced personnel under appropriate monitoring and with adequate preparation.[2,10] Careful patient selection, preprocedural optimization, and adherence to standardized protocols are essential to maximize benefits while minimizing risks in this vulnerable population.

In addition, FOB has a well-established role in the evaluation and management of ventilator-associated pneumonia (VAP), allowing precise lower airway sampling and facilitating early, targeted treatment strategies in critically ill patients.[4,9] The growing body of evidence supporting its diagnostic accuracy, therapeutic effectiveness, and acceptable safety profile has led to increasing integration of FOB into routine ICU practice. Consequently, FOB continues to play a pivotal role in influencing clinical decision-making, improving patient outcomes, and reducing reliance on more invasive diagnostic and therapeutic interventions.[1,6,10]

MATERIALS AND METHODS

This prospective observational study was conducted in the multispecialty intensive care unit of a tertiary care teaching hospital over a defined study period after obtaining approval from the Institutional Ethics Committee. The study included a total of 77 patients admitted to the ICU with respiratory complications who required flexible fiberoptic bronchoscopy as part of their diagnostic or therapeutic management. Written informed consent was obtained from each patient or from the legally authorized representative in cases where the patient was unable to provide consent due to critical illness.

All enrolled patients underwent a detailed clinical evaluation that included demographic characteristics, primary diagnosis, indication for bronchoscopy, respiratory status, and requirement for mechanical ventilation. Flexible fiberoptic bronchoscopy was performed at the bedside under strict aseptic precautions using standard bronchoscopic equipment. The procedure was carried out by experienced pulmonologists or intensivists. Continuous monitoring of oxygen saturation, heart rate, blood pressure, and electrocardiography was maintained throughout the procedure. Supplemental oxygen was administered as required, and ventilator settings were appropriately adjusted in mechanically ventilated patients to maintain adequate oxygenation and ventilation during the procedure.

Bronchoscopy was performed for diagnostic indications such as persistent or unexplained lung collapse, suspected pulmonary infection, hemoptysis, or unexplained respiratory deterioration, as well as for therapeutic purposes including removal of mucus plugs, bronchial toileting, and clearance of airway secretions. Bronchoalveolar lavage or bronchial aspirate samples were obtained when clinically indicated and sent for microbiological and cytological analysis. Bronchoscopic findings, therapeutic interventions performed, and immediate procedural outcomes were documented. Patients were closely observed following bronchoscopy for any procedure-related complications such as hypoxemia, bleeding, hemodynamic instability, or arrhythmias.

Data collected were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software, version 25.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean with standard deviation or median with interquartile range as appropriate. Associations between bronchoscopic indications, findings, therapeutic outcomes, and complications were assessed using the Chi-square test or Fisher's exact test for categorical variables. A p-value of less than 0.05 was considered statistically significant.

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Approval was obtained from the Institutional Ethics Committee prior to commencement of the study. Confidentiality of patient information was strictly maintained, and participation in the study did not influence or alter the standard clinical care provided to the patients.

RESULTS

[Table 1] summarizes the initial chest radiographic findings among the 77 ICU patients undergoing flexible fiberoptic bronchoscopy. Lobar collapse was the most frequent finding, observed in 34 patients (44.2%), followed by pulmonary infiltrates in 28 patients (36.4%). Multilobar collapse was seen in 11 patients (14.3%), while whole lung collapse was relatively uncommon, noted in only 4 patients (5.1%). These findings indicate that lung collapse, either lobar or multilobar, constituted the

predominant radiographic abnormality prompting bronchoscopy in the study population.

[Table 2] depicts changes observed in chest radiographs 6 hours after bronchoscopy in patients with radiologically confirmed lung atelectasis (n = 49). Partial re-expansion was the most common outcome at 6 hours, seen in 24 patients (49.0%), while complete re-expansion was observed in 15 patients (30.6%). No radiographic improvement was noted in 10 patients (20.4%). Among patients with lobar collapse, partial and complete re-expansion were observed in 10 (35.7%) and 9 (32.1%) cases respectively. Patients with multilobar collapse predominantly showed partial re-expansion (72.7%), whereas whole lung collapse demonstrated partial re-expansion in 2 out of 4 cases. These findings suggest early radiographic improvement following bronchoscopy in a substantial proportion of patients.

[Table 3] shows chest radiographic changes 24 hours after bronchoscopy in the same subset of patients with lung atelectasis (n = 49). Complete re-expansion was observed in 26 patients (53.1%), indicating progressive radiological improvement over time. Partial re-expansion persisted in 16 patients (32.7%), while lack of resolution was noted in only 7 patients (14.2%). Among lobar collapse cases, complete re-expansion increased to 17 patients (60.7%) at 24 hours. Multilobar collapse showed complete re-expansion in 5 patients (45.5%), and partial re-expansion in 6 patients (54.5%). Whole lung collapse showed partial re-expansion in all cases without complete resolution. The improvement from 6 to 24 hours was statistically significant ($p < 0.05$), indicating the sustained therapeutic benefit of bronchoscopy in lung re-expansion.

Table 1: Initial chest radiograph findings (n = 77)

Initial Chest Radiograph Findings	n	%
Lobar collapse	34	44.2
Multilobar collapse	11	14.3
Whole lung collapse	4	5.1
Pulmonary infiltrates	28	36.4
Total	77	100

Table 2: Changes in post-bronchoscopy chest radiograph after 6 hours in patients with lung atelectasis (n = 49)

Initial chest radiograph	Non-resolution n (%)	Partial re-expansion n (%)	Complete re-expansion n (%)	Total
Lobar collapse	9 (32.1)	10 (35.7)	9 (32.1)	28 (100)
Multilobar collapse	1 (9.1)	8 (72.7)	2 (18.2)	11 (100)
Whole lung collapse	0 (0)	2 (50.0)	2 (50.0)	4 (100)
Total	10 (20.4)	20 (49.0)	13 (26.6)	49 (100)

Table 3: Changes in post-bronchoscopy chest radiograph after 24 hours in patients with lung atelectasis (n = 49)

Initial chest radiograph	Non-resolution n (%)	Partial re-expansion n (%)	Complete re-expansion n (%)	Total
Lobar collapse	5 (17.9)	6 (21.4)	17 (60.7)	28 (100)
Multilobar collapse	1 (9.1)	6 (54.5)	4 (36.4)	11 (100)
Whole lung collapse	1 (25.0)	3 (75.0)	0 (0)	4 (100)
Total	7 (14.2)	15 (30.6)	21 (42.9)	49 (100)

DISCUSSION

Flexible fiberoptic bronchoscopy (FOB) plays a crucial role in the management of respiratory complications in critically ill patients, particularly those with lung collapse and impaired secretion clearance. In the present study, lobar collapse was the most common initial chest radiographic finding, accounting for 44.2% of cases, followed by pulmonary infiltrates and multilobar collapse. These findings are consistent with earlier ICU-based studies that report atelectasis and secretion-related airway obstruction as the predominant indications for bronchoscopy in mechanically ventilated and critically ill patients.[11] The high prevalence of lung collapse in the present cohort underscores the importance of early bronchoscopic intervention to restore airway patency and improve ventilation.

The radiological response observed after bronchoscopy highlights its therapeutic effectiveness. At 6 hours post-procedure, partial or complete lung re-expansion was observed in nearly 80% of patients with atelectasis, indicating an early beneficial effect of bronchoscopic secretion clearance and mucus plug removal. Similar early radiographic improvements following FOB have been reported by Kreider and Lipson, who demonstrated significant lung re-expansion within hours of bronchoscopy in ICU patients with lobar and multilobar atelectasis.[12] The early response observed in the present study supports the use of FOB as a rapid therapeutic intervention in patients with acute lung collapse.

At 24 hours post-bronchoscopy, the proportion of patients showing complete re-expansion increased to 53.1%, with a corresponding reduction in non-resolution cases to 14.2%. This progressive improvement over time suggests that the benefits of FOB are sustained beyond the immediate post-procedure period. Previous studies have similarly shown that radiographic resolution continues over 24–48 hours following bronchoscopy, particularly when combined with appropriate ventilatory strategies and physiotherapy.[13] The significant improvement observed between 6 and 24 hours in

the present study reinforces the role of FOB in achieving durable lung recruitment in critically ill patients.

The response pattern varied according to the type of collapse. Patients with lobar collapse demonstrated the highest rates of complete re-expansion at 24 hours, whereas multilobar and whole lung collapse showed relatively slower or partial improvement. This observation aligns with published literature suggesting that focal airway obstruction responds more favorably to bronchoscopic intervention than diffuse or extensive lung involvement.[14] Whole lung collapse, often associated with severe underlying pathology or prolonged obstruction, may require repeated interventions or adjunctive therapies for optimal recovery.

The safety profile of FOB, as reflected by the absence of major complications in the present study, further supports its use in ICU settings. Although critically ill patients are inherently at higher procedural risk, multiple studies have confirmed that FOB can be performed safely at the bedside with appropriate monitoring and expertise.[11,15] When judiciously used, FOB not only improves radiographic outcomes but also contributes to better oxygenation, ventilatory mechanics, and overall clinical stabilization.

CONCLUSION

The present study demonstrates that flexible fiberoptic bronchoscopy is an effective and safe therapeutic modality for managing lung atelectasis in critically ill patients. Significant radiographic improvement was observed as early as 6 hours after bronchoscopy, with further enhancement at 24 hours, particularly in patients with lobar collapse. These findings support the routine use of FOB in ICU patients with radiologically confirmed lung collapse to facilitate early lung re-expansion and improve respiratory outcomes.

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