Original Article

Comparison of the Patient Diagnostic Yield of Fibre-optic Bronchoscopy with Conventional Tracheal Aspirate

Subodh Sagar Dhakal[1], Navin Kumar Mishra[2], Karuna Bhatta[3], Milan Shrestha[4], Rohit Karna[4], Arjan Khanal[4]

[1]Department of Medicine, OM Hospital and Research Center, [2]MD- Respiratory Medicine, Consultant Pulmonologist, [3]Department of Internal Medicine, [4]Medicine Resident Doctor at Kathmandu Medical College Teaching Hospital, Kathmandu

Abstract

Introduction: Flexible fibre-optic bronchoscope (FFB) has become an indispensable tool in the optimal management of intensive care unit (ICU) patients with both diagnostic and therapeutic goals. The most common indication of flexible bronchoscopy in the studies was the collection of respiratory samples for microbiological evidence in patients with clinically or radiologically suspected respiratory infection.

Objective: To know the efficacy of Bronchoalveolar Lavage (BAL) in establishing diagnosis and its impact on overall health status of the patients.

Methods: A single center, longitudinal study involving 40 patients aged > 18 years old with septic shock with similar baseline characteristics was conducted. Two study arms, 20 patients in intervention arm - patient with utilization of Bronchoscopy and BAL in aiding diagnosis and 20-patients in conservative- arm without Bronchoscopy were compared in terms of establishing diagnosis primarily and secondarily in terms of length of stay and 30-day mortality. We were able to identify following organisms in BAL sample: *M*ycobacterium tuberculosis- 4, *A*cinetobacter baumanii- 3, *P*seudomonas aeruginosa- 2, Klebsiella oxytica- 2, *E*. coli- 2, *S*treptococcus pneumoniae- 2, *S*taphyloccus aureus- 1.

Results: We were able to identify various infectious agents as mentioned above 16/20 in BAL group compared to 8/20 in conventional arm; neoplasm in 4 out of 20 subjects in BAL group. In 80% of cases, BAL helped in identifying the organisms compared to only 40% in tracheal aspirate group. In addition, six cases in Intervention arm vs. nine cases in conventional arm had more than > 14 days hospital stay with the p-value 0 .492091. Interventional arm had lesser mortality 5 cases vs. 7 cases in Conventional arm with the p-value of 0.490153 which was not statistically significant.

Conclusion: We conclude that the diagnostic bronchoscopy and related procedures among critically ill patients are helpful in identifying the pathogens and in detecting malignancy.

Key words: Tracheal Aspirate, Broncho Alveolar Lavage, Intensive care Unit

Introduction

Flexible fibreoptic bronchoscope (FFB) has become an indispensable tool in the optimal management of intensive care unit (ICU) patients with both diagnostic and therapeutic goals. In expert hands with appropriate precautions, its safety and usefulness have led to its increasing use in critical patients and on mechanical ventilators. Bronchoscopy seems to be under utilized in our country.

Since the introduction of flexible bronchoscopes (initially measuring 4.9 mm in diameter in the 1970s and posteriorly of other diameters), their

Address for correspondence
Dr. Subodh Sagar Dhakal
Consultant Physician,
OM Hospital and Research center
Email: dhakalsubodh22@gmail.com

use for diagnostic and therapeutic purposes in critical patients subjected to mechanical ventilation and in Intensive Care has become widespread. Thirty years ago, the main instrument for the direct examination of the tracheobronchial tree was the rigid bronchoscope and today is considered the procedure of choice in only two emergencies, hemoptysis and removal of foreign bodies. Flexible fiberoptic bronchoscopy (FFB) has become the procedure of choice in most examinations of the tracheobronchial tree.[1] In fact, flexible bronchoscopy has been shown to be very effective as an aid to other procedures such as selective intubation or visual control during percutaneous tracheostomy. Considering these studies together with previous publications, it is notorious that although a large percentage of microbiological studies prove negative, flexible bronchoscopy makes a significant contribution to patient clinical management in almost one-half of all cases in which the technique is indicated.

The most common indication of flexible bronchoscopy in the studies was the collection of respiratory samples for microbiological study in patients with clinically or radiologically suspected respiratory infection. Critically ill patients in the ICU are common to have respiratory involvement, with 30-50% of the admissions requiring the use of mechanical ventilation.[2] An early and specific etiological diagnosis of nosocomial pneumonia or ventilator associated pneumonia, or in patients with comorbidities or immune suppression, is of great prognostic relevance. In this sense, it should be remembered that bronchial aspiration, particularly bronchoalveolar lavage and telescopic protected catheter bronchial brush, are the most widely used techniques.

There are practically no strict contraindications to bronchoscopy in the Intensive Care Unit. In this context, serious coagulation disorders, very severe and refractory hypoxemia, intense hemodynamic instability despite the use of vasoactive drugs, uncontrolled arrhythmias or acute myocardial ischemia are all situations in which bronchoscopy is not advisable except when its use implies important potential benefit (e.g. the resolution of atelectasis).

With regard to safety, the data presented are consistent with the findings of earlier studies which suggest that bronchoscopy in the Intensive Care Unit is generally safe, and that while some patients (10-15%) develop complications during the procedure (hypoxemia, hypotension, tachycardia, extrasystoles, etc.), these tend to be transient and of scant clinical importance. Bronchoscopy is usually performed in the sedated patient (cough complicates or hinders exploration), and volume control is the most frequently used ventilation mode. For safety reasons, a 100% inspiratory oxygen fraction (FiO2) is used and in order to lessen the risk of barotraumas, we suspend positive end-expiratory pressure (PEEP) or keep it at $\leq$ 5 mmHg during the procedure. Nevertheless, if necessary, and under adequate supervision, bronchoscopy can be performed with pressure-controlled ventilation modes.

Flexible bronchoscopy is a pneumological technique that allows us to quickly visualize and gain access to the airway, with a broad range of diagnostic and therapeutic indications. These characteristics, and the safety and efficacy data provided by the studies carried out to date, justify inclusion of the technique among the possibilities and resources available in the Intensive Care Unit. It is also clear that flexible bronchoscopy is an invasive procedure, and should be performed by people with the theoretical knowledge and practical experience. In effect, the obtainment of good results is only possible if the professional performing the technique has received the required training.

In BAL, the FFB is wedged into a sub segmental bronchus and multiple aliquots (20 to 50 ml) of saline are instilled into desired bronchus and the contents are aspirated. The sample obtained is centrifuged and processed for the opportunistic organisms and for abnormal cells. A volume of 100 to 120 ml instilled into a single segment is sufficient to perfuse the entire segment. For clinical purposes, a total lavage volume of at least 100 ml is used, and a total return of at least 40 ml is required for adequate specimens. Recent literature demonstrates that lavage volume of up to 300 ml is well tolerated.[3]

The main goal of this study was to find out if Bronchoscopy in critically ill patients with lung involvement would contribute to overall identification of pathogens and improving health of an individual.

Methodology

A single center, longitudinal study involving 40 patients admitted in OM Hospital and Research Center- ICU aged > 18 years old with septic shock with similar baseline characteristics, including SOFA, qSOFA and SIRS was carried out. The investigators obtained ethical clearance from Om Hospital and Research Center prior to enrolling patients into study after submitting the proposal to Hospital ethical clearance committee. Written informed consent was obtained from the participants prior to enrolling them to either arm. Moreover, Patients were randomly assigned to two study arms, 20 patients in intervention arm- patient with utilization of Bronchoscopy and BAL in aiding diagnosis and 20 patients in conservative- arm without Bronchoscopy were compared in terms of: establishing diagnosis primarily, and secondarily in terms of length of stay and 30-day mortality.

Bronchoscopy was done among cohort of intervention arm who were admitted to ICU under conscious sedation using midazolam (0.1-0.2 mg/ kg) and/or Fentanyl (1-2 mcg/ kg) in standard dose together with local spray of 10% lignocaine into oral cavity and local instillation of 2% lignocaine into tracheo-bronchial tree BAL was collected from affected lobe as well as from middle and lower lobe with instillation of 30-50 ml of normal saline with proper wedging of the bronchoscope to prevent spillage of specimen to adjacent segment. However, Tracheal Aspirates from patients in conservative arm were collected using wall mount suction. In both arms, samples were taken in adequate amount with standard procedures. All the samples were collected using standard technique keeping in mind the possibility of contamination and were immediately subjected to quantitative culture and routine examination and cytological evaluation. Sample submitted for analysis was adequate in volume with sufficient amount of alveolar macrophages on evaluation.

The study was conducted from October 1, 2019 to December 31, 2019.

Table 1: Baseline characteristics

Variables	Interventional arm	Conservative arm
Male	12	8
Female	9	11
Age in years (mean)	32 ± 4	35 ± 2
BP (mmhg) Systolic Diastolic	 94 ± 6 54 ± 4	 90 ± 5 54 ± 4
HR (bpm)	114 ± 5	110 ± 7
RR (cpm)	34 ± 4	33 ± 5
SOFA	14 ± 4	15 ± 2
qSOFA	3 ± 1	3 ± 1
SIRS	3 ± 1	3 ± 1

Remarks: BP= Blood Pressure, mmhg= Millimeter of Mercury, HR= Heart Rate, RR= Respiratory rate, SOFA= Sequential organ Failure Assessment, qSOFA= quick SOFA, SIRS= Systemic Inflammatory Response Syndrome, bpm= beats per minute, cpm= cycle per minute.

Statistics

Data were analyzed using appropriate statistical tools using statistical products and service solutions (SPSS 20) version 20 software developed by IBM. Descriptive statistics were performed and t-test, chi-square were used. Non-numerical data were presented as frequency and percentage. Analytical statistics was performed; the χ^2-test was used to examine the relationship between two qualitative variables. A *P*-value of more than 0.05 was considered as non-significant, *P* value of less than 0.05 as significant, and *P* value of less than 0.01 as highly significant. All the data and outcomes of the study were obtained and recorded carefully.

Results

Table 2: Microbiology profile

Group	Positive	Negative	Total
BAL	16	4	20
Tracheal aspirate	8	12	20

The chi-square statistic is 6.6667. The p-value is 0.009823. The result is significant at $p < .05$.

In 80% of cases, BAL helped in identifying the organisms in compared to tracheal aspirate group where organism was identified only in 40% of cases. Thus, the microbiology yield was twice in BAL group compared to the Tracheal Aspirate group.

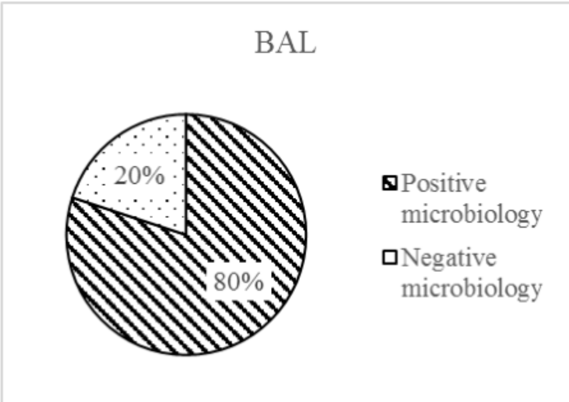

Figure 1: BAL Positivity

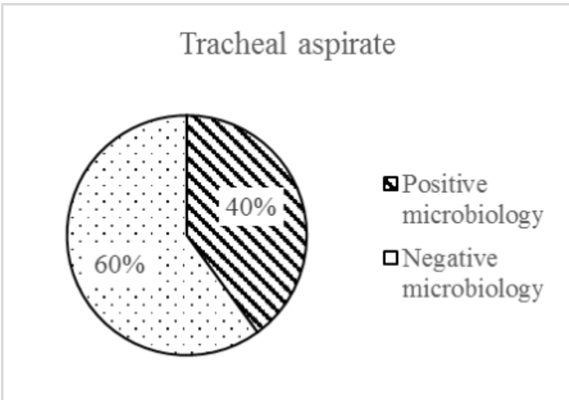

Figure 2: Tracheal Aspirate profile

Table 3: Microbiological yield by organisms

Organisms	Bal	Tracheal aspirate
Acinetobacter baumanii	3	0
Pseudomonas aeruginosa	2	1
Klebsiella oxytica	2	1
E. coli	2	1
Staph. aureus	1	3
Strep. pneumoniae	2	2
M. Tbc.	4	0

Table 4: Length of stay in hospital

Length of stay (days)	BAL	Tracheal aspirate
< 7	7	4
7- 14	7	7
> 14	6	9

The chi-square statistic is 1.4182. The p-value is 0.492091. The result is not significant at $p < 0.05$

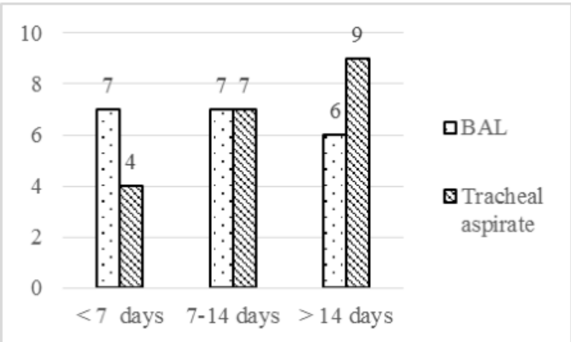

Figure 3: Bar diagram representing length of stay of the patients

Table 5: Thirty day Mortality

Group	Mortality	Survival	Total
BAL	5	15	20
Tracheal aspirate	7	13	20

The chi-square statistic is 0.4762. The p value is 0.490153. The result is not significant at $p<0.05$.

Table 6: Comparison of 30 day Mortality

30-day mortality	BAL	Tracheal aspirate
< 7	2	1
7- 14	1	3
> 14	2	3
Total	5	7

The chi-square statistic is 1.2343. The p-value is 0.539484. The result is not significant at $p< 0.05$.

Table 7: Detection of Malignancy

Variable	Bal	Tracheal aspirate
Malignancy	3	none
Histopathology	Adenocarcinoma –1 Squamous cell CA -1 Small cell lung cancer-1	

Three patients in BAL group were diagnosed with lung malignancy compared to none in tracheal aspirate group.

Discussion

The study showed the utility of BAL in identifying organisms better than that of tracheal aspirate. In 80% of cases, BAL helped in identifying the organisms in comparison to tracheal aspirate group where organism was identified only in 40% of cases. Thus, the microbiology yield was twice in BAL group compared to the tracheal aspirate group.

Three multidrug-resistant Gram-negative bacteria have emerged in many medical centers as particularly troublesome pathogens. In the study, BAL aspirate was found as a better tool in isolating those troublesome pathogens. *Pseudomonas aeruginosa* is a frequent cause of respiratory, surgical site and urinary tract infections in patients from intensive care areas. Several studies have documented increasing resistance rates in *P. aeruginosa* to fluoroquinolones, cephalosporins and carbapenems, particularly among ICU isolates.[4] *Acinetobacter baumannii* is being recognized as an emerging pathogen in many medical facilities. According to NNIS data, the proportion of infections due to *Acinetobacter* spp. has increased, and accounts for ~7% of ICU-related pneumonias. In several wide-scale surveillance studies, carbapenem, cephalosporin and ciprofloxacin resistance rates have approached ~20%, ~50% and ~50%, respectively. Infections due to multidrug-resistant *Acinetobacter baumannii* have been associated with increased length of hospital and ICU stays, and a polymyxin is often the antimicrobial agent of last resort.[5] *Klebsiella pneumoniae* is also a well-recognized nosocomial pathogen, and an important cause of pneumonia and urinary tract infections in the ICU setting. Since the early 1990s, extended-spectrum β-lactamase (ESBL)- possessing *K. pneumoniae* have rapidly emerged.[6,7]

Also, BAL aspirate was useful in identifying four tuberculosis cases, which in turn would have a massive impact on the morbidity and mortality in ICU especially in a country like Nepal where prevalence of mycobacterium tuberculosis is nearly 45% in general population.

The results are similar to the study by Johannes B et al. who concluded in hospitals where BAL analysis are routine practice and thus, are readily available, this diagnostic modality is probably more accurate and thus, preferable over ETA analysis in patients with suspected VAP.[8] In a study by Allan S et al., cultures were more likely to be positive in BAL patients than in endotracheal-aspiration patients (60% vs. 52%).[9-11]

The study did not find any statistically significant difference in the duration of hospital stay and mortality in tracheal aspirate vs. BAL group. Mortality and antibiotic use were similar whether cultures were obtained by bronchoalveolar lavage or by endotracheal aspiration. It could be due to the fact that BAL in this study was used as a diagnostic tool rather than an interventional measure.

BAL was also noted as a superior tool in detecting malignancies which would not have been identified with the tracheal aspirate only. It can totally change the outcome with short term and long-term prognosis of the patients. A similar study by Sistla Radha et al. also concluded increased case detection rate for malignancies using BAL technique.[12,13]

Limitation of study

The author admits that it had a small sample size. Patient undergoing tracheal aspirate did not undergo Bronchoscopy and BAL in cases where Tracheal aspirate was negative. In addition, the author also did not primarily power the study in terms of outcome.

Conclusion

We conclude that the diagnostic bronchoscopy and related procedures are helpful in identifying the pathogens and malignancy among critically ill patients. The author believes that bronchoscopy in critical care set-up be used as needed because of its advantage and being relatively safe in expert hands.

Competing interest: None.

References

1. Estella A. Broncho alveolar lavage for

pandemic influenza A (H1N1) v pneumonia in critically ill patients. Intensive Care Med 2010; 36:1976–1979.

2. Gilda DF, Sindhaghatta KV. Role of flexible-bronchoscopy in pulmonary and critical care practice. Global Perspectives Bronchoscopy 2012; 51:953–978.
3. W. Radyet al, Role of bronchoscopy during non invasiveventilation in hypercapnic respiratory failure, Egyptian Journal of Chest Diseases and Tuberculosis, 2014.06.015, http://dx.doi.org/10.1016/ j.ejcdt. 2014.06.015
4. Gaynes R, Edwards JR. National Nosocomial Infections Surveillance System. Overview of nosocomial infections caused by Gram-negative bacilli, Clin Infect Dis, 2005, vol. 41 (pg. 848-54.
5. The Canadian Critical Care Trials Group. A randomized trial of diagnostic techniques for ventilator-associated pneumonia. N Engl J Med 2006 Dec 21; 355:2619-30.
6. Radha S, Afroz T, Prasad S, Ravindra N. Diagnostic utility of bronchoalveolar lavage. J Cytol. 2014;31(3):136–138. doi:10.4103/0970-9371.145636.
7. Scholte JBJ, van Dessel HA, Linssen CFM, Bergmans DCJJ, Savelkoul PHM, Roekaerts PMHJ, et al. Endotracheal Aspirate and Bronchoalveolar Lavage Fluid Analysis: Interchangeable Diagnostic Modalities in Suspected Ventilator-Associated Pneumonia? McAdam AJ, editor. J Clin Microbiol [Internet]. 2014 Oct 1;52(10):3597 LP-3604. Available from: http://jcm.asm.org/content/52/10/3597.abstract
8. Kim M. G. Smeijsters et. al, Effect of Bronchoscopy on Gas Exchange and Respiratory Mechanics in Critically Ill Patients With Atelectasis: An Observational Cohort Study.Front Med (Lausanne). 2018; 5: 301.doi.org/10.3389/fmed.2018.00301.
9. SKabadayi et al., Bronchoscopy in critical care. BJA Education, 17 (2): 48–56-2017. Advance Access Publication Date: 2 June 2016 56 (2017).
10. I. Martin-Loeches et al, Current status of fiberoptic bronchoscopy in intensive care medicine. Med Intensiva. 2012; 36(9) :644---649.
11. Paul Ellis Marik et. al, Bronchoscopy in the Intensive Care Unit. Handbook of Evidence-Based Critical Care.2015. ISBN 978-3-319-11020-2 pp 95-99
12. A. Torrego Fernández et al, Flexible bronchoscopy in critical care units.2012.Vol. 36. Issue 6.pages 385-386 , 10.1016/j.medine.2012.08.002. DOI: 10.1016/j.medine.2012.08.002
13. Centers for Disease Control and PreventionNational nosocomial infections surveillance (NNIS) system report, data summary from January 1992 through June 2004, issued October 2004, Am J Infect Cont, 2004, vol. 32 (pg. 470-85).