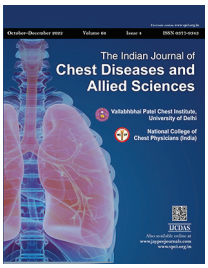
CASE REPORT

Endobronchial Ultrasound Bronchoscopy in Patients with Acute Respiratory Failure on Noninvasive Ventilation: Report of Two Cases



This article is available on www.vpci.org.in

Onkar K Jha[1], Sapna Yadav[2], Mrinal Sircar[3], Noopur Gupta[4]

Received on: *01 February 2021;* Accepted on: *14 June 2021;* Published on: *05 January 2023*

Abstract

Fiberoptic bronchoscopy (FOB) has simplified the direct examination of the lungs and is widely used for diagnosis and therapy. Fiberoptic bronchoscopes occupy a significant proportion of cross-section area of central airways, which can affect lung mechanics and gas exchanges that may lead to desaturation and cardiac arrhythmia. This makes bronchoscopy in critically ill patients with respiratory failure even more challenging. Use of noninvasive mechanical ventilation (NIV) may help to avoid use of invasive mechanical ventilation in selected patients with acute respiratory failure. It has been shown to be useful in hypoxemic patients to facilitate bronchoscopic examination for bronchoalveolar lavage, bronchial brushing, endobronchial biopsy (EBB), and transbronchial lung biopsy (TBLB). Noninvasive mechanical ventilation has also been used to facilitate other endoscopic procedures including transesophageal echocardiography (TEE) and upper gastrointestinal endoscopy for diagnostic and therapeutic interventions in hypoxemic patients. Endobronchial ultrasound (EBUS) bronchoscope, having a wider diameter than a conventional bronchoscope, may have a more pronounced effect on lung mechanics and gas exchanges, and its use in patients on NIV has not been reported. Contraindications of EBUS are mostly relative and similar to FOB. There are several studies suggesting the safety of NIV-supported FOB in hypoxemic patients. We describe our experience of the first two EBUS bronchoscopies and transbronchial needle aspiration (TBNA) was done in hypoxemic patients with NIV support.

Keywords: Bronchoscopy, Endobronchial ultrasound, EBUS–transbronchial needle aspiration, Fiberoptic bronchoscopy, Noninvasive ventilation, Respiratory failure.

The Indian Journal of Chest Diseases and Allied Sciences (2022): 10.5005/jp-journals-11007-0041

Abbreviations used in this Article

FOB = Fiberoptic bronchoscopy; NIV = Non-invasive mechanical ventilation; EBB = Endobronchial biopsy; TBLB = Transbronchial lung biopsy; TEE = Transesophageal echocardiography; EBUS = Endobronchial ultrasound; TBNA = Transbronchial needle aspiration; FiO_2 = Fraction of inspired oxygen; SpO_2 = Arterial oxygen saturation; ABG = Arterial blood gas; PaO_2 = Partial pressure of arterial oxygen; $PaCO_2$ = Partial pressure of arterial carbon dioxide; HCO_3 = Bicarbonate; IPAP = Inspiratory positive airway pressure; EPAP = Expiratory positive airway pressure.

Introduction

Performing fiberoptic bronchoscopy in critically ill patients with respiratory failure is challenging. Between 10% and 15% of the tracheal lumen is occupied by the bronchoscope, which can lead to oxygen desaturation and even cardiac arrhythmias.[1] This effect may be more pronounced while performing EBUS bronchoscopy as its widest diameter (6.9 mm, Olympus, BF-UC180F) corresponds to cross-sectional area of 37.39 mm^2. Assuming minimum computed tomogram-based calculated cross-sectional area as 120 mm^2 in women and 190 mm^2 in men, an EBUS bronchoscope will occupy up to 31.16% (in females) and 19.68% (in males) of tracheal cross-sectional area.[2] In acute respiratory failure, noninvasive ventilation (NIV) may help in avoiding invasive mechanical ventilation.[3] Noninvasive ventilation has been reported to facilitate diagnostic bronchoscopy in hypoxemic patients.[4–6]

[1–3]Department of Pulmonology and Critical Care, Fortis Hospital, Noida, Uttar Pradesh, India

[4]Department of Pathology, Fortis Hospital, Noida, Uttar Pradesh, India

Corresponding Author: Mrinal Sircar, Department of Pulmonology and Critical Care, Fortis Hospital, Noida, Uttar Pradesh, India, Phone: +91 9871292226, e-mail: mrinalsircar@yahoo.co.uk

How to cite this article: Jha OK, Yadav S, Sircar M, *et al.* Endobronchial Ultrasound Bronchoscopy in Patients with Acute Respiratory Failure on Noninvasive Ventilation: Report of Two Cases. Indian J Chest Dis Allied Sci 2022;64(4):292–296.

Source of support: Nil

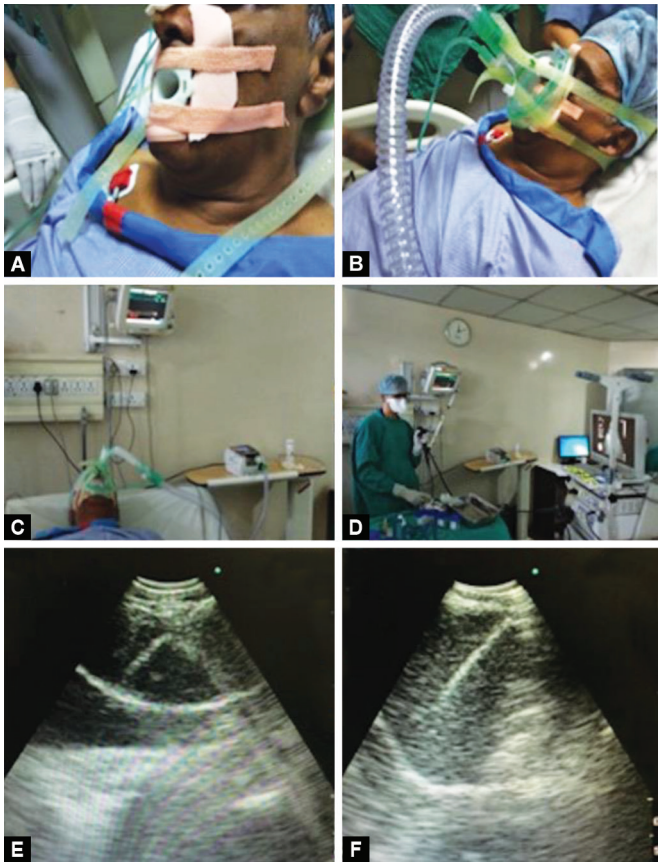
Conflict of interest: None

We describe our experience of using EBUS bronchoscope in two hypoxemic patients on NIV (Figs 1A to D).

Case Description

Case 1

An 80-year-old male, an ex-smoker (40 pack years) with respiratory distress and hypoxemia, was referred to us from another hospital. He was managed with NIV, antibiotics, and bronchodilators. The right hilum was prominent on chest radiography (Fig. 2A). Contrast-enhanced computed tomography of the chest showed right hilar and mediastinal lymphadenopathy (Fig. 2B) with central necrosis.



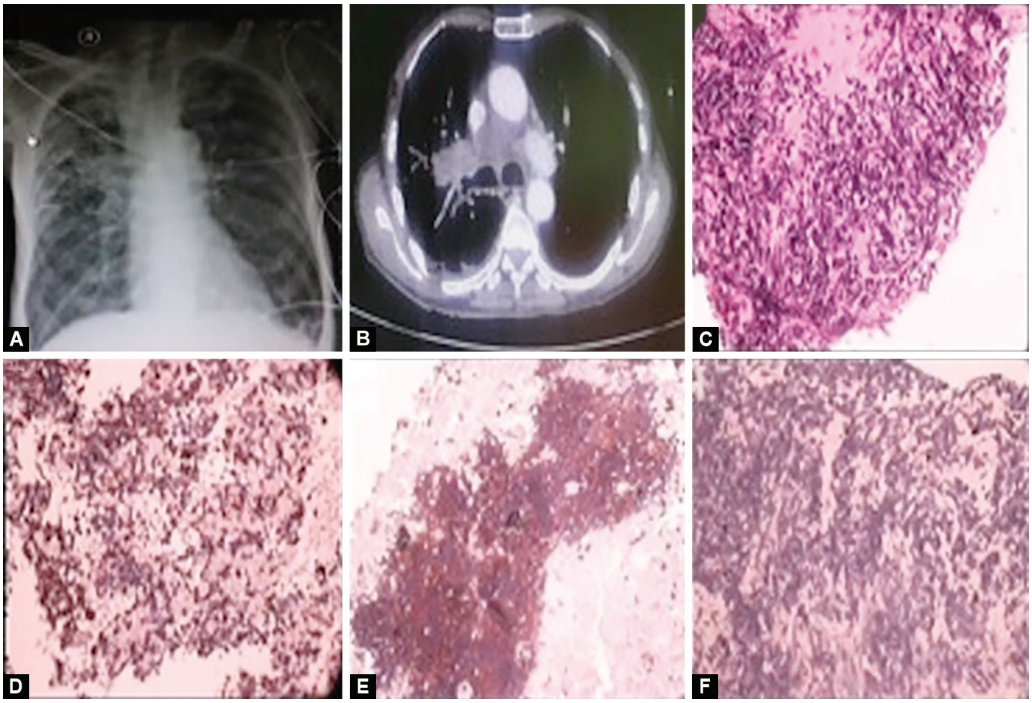
Figs 1A to F: EBUS–TBNA in patient on noninvasive ventilation (A) Mouth guard; (B) Anesthetic face mask; (C) Catheter mount and NIV through face mask; (D) EBUS in patient on NIV through face mask; (E) EBUS–TBNA case 1; and (F) EBUS–TBNA case 2

Bronchoscopy (Olympus BF-1T30) and EBUS (Olympus, BF-UC180F) bronchoscopy-guided trans-bronchial needle aspiration (TBNA) was done through anesthesia face mask secured with straps to cover the mouth and nose, and a mouthguard (secured by tapes) (Figs 1A and B). A catheter mount with a bronchoscopy port was attached and bilevel NIV (Stellar 150, ResMed) was delivered via a single-limb circuit with oxygen bleed-in port (Fig. 1C). As the bronchoscopy port was tight for EBUS scope, its cap was opened to advance EBUS scope (Fig. 1D) and air leak was minimized manually by holding the bronchoscope and catheter mount together with a gloved hand.

The TBNA was performed from subcarinal site (Fig. 2E). There were brief (lasting for >10 seconds but <30 seconds) intra-procedure and immediate post-procedure desaturation (SpO_2 <90%) that improved with a transient increase in oxygen flow. Minimum oxygen saturation noted on the monitor was 79% (Table 1). Cytology was normal in bronchoalveolar lavage (BAL); stain for acid-fast bacilli (AFB), GeneXpert, and culture for tuberculosis were negative. Histopathology of TBNA cell block (Fig. 2C) showed small atypical cells with crush artifacts, while immunohistochemistry (IHC) was consistent with small-cell carcinoma (Figs 2D to F). After discussion with family and patient no further escalation of treatment was agreed upon.

Case 2

A 69-year-old male, ex-smoker (15 pack years) presented to the outpatient department with breathlessness and productive cough since 2 weeks. Chest radiograph showed right lower zone opacity (Fig. 3A) and a CECT (Fig. 3B) showed mediastinal lymphadenopathy, patchy consolidation involving the right middle and lower lobe, and a nodular opacity in the posterior basal segment of the right lower lobe. Sputum smear examination showed acid-fast bacilli. *Mycobacterium tuberculosis* was confirmed

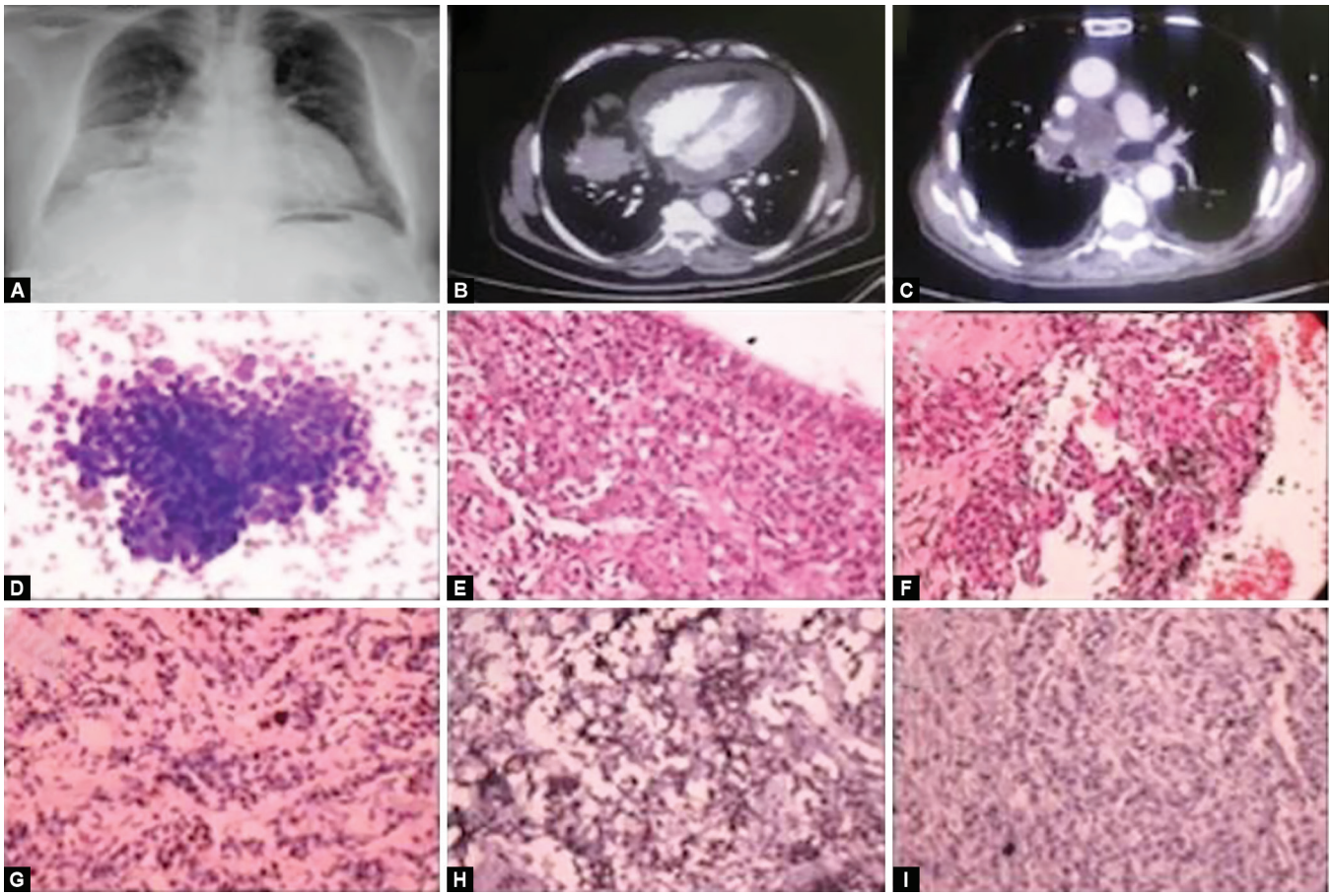


Figs 2A to F: Case 1. (A) Chest right hilar prominence; (B) CT chest conglomerated mediastinal lymph node mass; (C) EBUS–TBNA cell block (H&E stain) showing small atypical cells with crush artifact; (D) High Ki-67 index; (E) Synaptophysin positive; and (F) CD56 positive

Table 1: Patient blood gas and other parameters

Parameters	*Case 1*				*Case 2*			
Age (years)	80				69			
Sex	Male				Male			
Comorbidity	Asthma, psoriasis, BPH				None			
Procedural sedation	1 mg midazolam, propofol infusion				None			
Oxygen supplementation (LPM)	10				6			
Estimated FIO_2*	44–56				38–44			
Intraprocedure SpO_2 minimum	79				82			
Complications	None				None			
ABG	*At admission*	*Pre-procedure*	*Post-procedure*	*Next day*	*At admission*	*Pre-procedure*	*Post-procedure*	*Next day*
pH	7.457	7.459	7.317	7.416	7.326	7.478	7.403	7.500
PaO_2 (mm Hg)	62.8	67.1	51.9	70.8	52.7	65.0	51.9	121.1
SpO_2 (%)	91.7	93.3	82.1	93.9	83	93.5	83.5	98.0
$PaCO_2$ (mm Hg)	31.2	30	45.7	47.3	52.9	47.8	57.1	41.9
HCO_3 (meq/L)	21.5	20.8	22.9	29.7	27	34.6	34.8	31.9
NIV-IPAP/EPAP (cm-H_2O)	16/6	16/8	16/8	16/8	14/6	14/8	16/6	16/6

*Eur. Respir. J 2002;19(4):653–657, England; Eur. Respir. J. 1996;9(4):834–836, England



Figs 3A to I: Case 2. (A) Chest X-ray showing enlarged cardiac shadow and right lower-zone opacity; (B) CECT chest showing mediastinal lymph node; (C) Pericardial effusion and right perihilar patchy consolidation extending to RML and RLL; (D) Pericardial fluid cytology MGG (May–Grunwald Giemsa) stain showing atypical cells; (E) Bronchial biopsy (H&E stain) showing large tumor cells arranged in insular pattern; (F) EBUS–TBNA cell block H&E stain showing large malignant cells; (G) High Ki67 index; (H) Synaptophysin positive; and (I) Neuron-specific enolase (NSE) positive

by GeneXpert. The patient started antituberculosis treatment. Spirometry revealed a reversible airway obstruction and formoterol-budesonide was started. Breathlessness worsened over the next 3 weeks, and the patient was shifted to the intensive care unit with oxygen supplementation. Computed tomographic pulmonary angiography (CTPA) ruled out pulmonary embolism. Contract-enhanced computed tomography (Fig. 3C) revealed worsened radiological picture and showed pericardial effusion. Echocardiography revealed impending cardiac tamponade, and 660 mL of serosanguinous pericardial fluid was aspirated. Evaluation of pericardial fluid showed atypical cells suspicious of malignancy (Fig. 3D). Positron emission tomographic (PET)-CT was done while the patient's respiration was supported by portable NIV with a battery backup which showed flurodeoxy glucose (FDG) avid mediastinal and abdominal left atrial pressure (LAP) and lesions in the lungs, liver, and rib cage. The patient's condition worsened further, leading to type-II respiratory failure, which was managed with increased bilevel NIV support.

Evaluation of abdominal and bony lesion was not considered due to small, low FDG avid lesions, large vessels in proximity, and possible need of general anesthesia. Bronchoscopy via NIV mask was done and was tolerated well by the patient, which encouraged attempting EBUS bronchoscopy too via NIV mask. The mucosa was abnormal in the left-upper, lower and right-middle lobes. Bronchoalveolar lavage (BAL) and brush smears were obtained from the right-middle lobe and subcarinal lymph nodes were sampled by EBUS–TBNA (Fig. 1F). Bronchoalveolar lavage did not reveal any AFB. Brush cytology showed malignant cells. Histology of bronchial biopsy (Fig. 3E), EBUS–TBNA cell-block histology (Fig. 3F), and IHC (Figs 3G to I) revealed high-grade neuroendocrine tumor (large-cell neuroendocrine carcinoma) and cell block was negative for epidermal growth factor receptor and EML4-ALK. After discussion with family and patient no further escalation of treatment (other than addition of etoposide) was agreed upon. Anti-tuberculosis regimen was continued. Patient died three weeks later from progressive respiratory failure.

Discussion

In acute respiratory failure, NIV decreases the need for intubation[3] and can facilitate FOB,[4–6] transesophageal echocardiography,[7] or upper gastrointestinal endoscopy procedures.[8] Bronchoscopy with NIV support was first described in 1996 in hypoxemic immunosuppressed patients with suspected pneumonia[4] and since then, NIV has also facilitated bronchoscopic bronchial toileting, BAL, brushing,[6,9] endobronchial biopsy,[5,6,9] and transbronchial biopsy[6] but not reported to support EBUS–TBNA, to the best of our knowledge.

Bronchoscope usually occupies 10–15% of tracheal lumen, whereas a 5.7-mm-diameter bronchoscope occupies 51% of cross-section of an 8 mm endotracheal tube that increases airway resistance 11 times, and a positive-end expiratory positive pressure (PEEP) effect up to 20 mm Hg.[10] Fiberoptic bronchoscopy also decreases tidal volume, the impact depends on respiratory tract caliber and bronchoscope diameter. All of the above effects are likely to be more pronounced during EBUS bronchoscopy owing to its larger diameter (6.9 mm).

When suction is applied during bronchoscopy, $PaCO_2$ rises by 30% and PaO_2 decreases by 40%. The underlying mechanism for this seems to be decreasing in expired tidal volume, and thus, decreasing the volume participating in gas exchange and decreasing PEEP causing alveolar closure.[11] In patients with obstructive airway diseases, bronchoscopy can promote air-trapping as functional residual capacity (FRC) and auto-PEEP increases. These effects can be deleterious in patients with hypercapnic respiratory failure. Performing FOB with NIV support can preserve oxygenation in hypoxemic patients,[4,5,12] facilitating BAL and other procedures. A randomized controlled trial[5] showed significantly higher SpO_2 values in patients on CPAP as compared with patients kept on oxygen alone, and five patients in the latter group needed mechanical ventilation following FOB. In severely hypoxemic patients, NIV was associated with significant improvement in PaO_2/FiO_2 ratio during FOB.[4] Hypoxemia during or immediately after taking BAL is the most common complication. The delay before normalization of gas exchange varies from about 15 minutes for normal lungs to several hours in severe parenchymal disease.[11] Our patients developed hypoxemia (SpO_2<90%) during the procedure, and it was corrected with an increase in oxygen supplementation. A fall in PaO_2 was also noted immediately after EBUS in both the patients but improved later with continuation of NIV. The $PaCO_2$ post-procedure persisted above the preprocedure level 24 hours after the procedure in Case 1, this may be attributable to his preexisting obstructive airway disease and use of sedation. Chiner et al. used nasal face mask for NIV while doing bronchoscopy through oral route, but these patients developed hypoxemia (SpO_2 <86%) during FOB despite NIV.[9] Antonelli et al. successfully used helmet NIV to facilitate FOB in a patient with respiratory failure.[12] In most other studies,[4,6] full-face mask was used during FOB, just like we did.

Though EBUS–TBNA is preferably done in stable patients, most of the contraindications are relative and similar to FOB.[13] The safety of EBUS–TBNA in special medical conditions has been investigated in studies expanding its safety domain.[14] A recent guideline[15] advocates the role of NIV in facilitating FOB in a patient with acute hypoxemia. We successfully managed to perform EBUS bronchoscopy in both patients with only transient and correctable blood gas abnormalities and without any adverse event. Definitive diagnosis was achieved with EBUS–TBNA without needing intubation during and immediately post-procedure, and this helped in deciding the further treatment plan.

In conclusion, we suggest that more studies are required to investigate NIV-facilitated EBUS–TBNA that should be contemplated only in ICU settings.

References

1. Murgu SD, Pecson J, Colt HG. Bronchoscopy during noninvasive ventilation: Indications and technique. Respir Care 2010;55(5): 595–600. PMID: 20420731.
2. Vock P, Spiegel T, Fram EK, et al. CT assessment of the adult intrathoracic cross section of the trachea. J Comput Assist Tomogr 1984;8(6):1076–1082. DOI: 10.1097/00004728-198412000-00007.
3. Rochwerg B, Brochard L, Elliott MW, et al. Official ERS/ATS clinical practice guidelines: Noninvasive ventilation for acute respiratory failure. Eur Respir J 2017;50(2):1602426. DOI: 10.1183/13993003.02426-2016.
4. Antonelli M, Conti G, Riccioni L, et al. Noninvasive positive-pressure ventilation via face mask during bronchoscopy with BAL in high-risk hypoxemic patients. Chest 1996;110(3):724–728. DOI: 10.1378/chest.110.3.724.
5. Maitre B, Jaber S, Maggiore SM, et al. Continuous positive airway pressure during fiberoptic bronchoscopy in hypoxemic patients: A randomized double-blind study using a new device. Am J Respir Crit Care Med 2000;162(3 Pt 1):1063–1067. DOI: 10.1164/ajrccm.162.3.9910117.

6. Sircar M, Jha OK, Chabbra GS, et al. Noninvasive ventilation-assisted bronchoscopy in high-risk hypoxemic patients. Indian J Crit Care Med 2019;23(8):363–367. DOI: 10.5005/jp-journals-10071-23219.
7. Guarracino F, Cabrini L, Baldassarri R, et al. Non-invasive ventilation-aided transoesophageal echocardiography in high-risk patients: A pilot study. Eur J Echocardiogr 2010;11(6):554–556. DOI: 10.1093/ejechocard/jeq019.
8. Cabrini L, Nobile L, Cama E, et al. Non-invasive ventilation during upper endoscopies in adult patients: A systematic review. Minerva Anestesiol 2013;79(6):683–694. PMID: 23419342.
9. Chiner E, Sancho-Chust JN, Llombart M, et al. Fiberoptic bronchoscopy during nasal non-invasive ventilation in acute respiratory failure. Respiration 2010;80(4):321–326. DOI: 10.1159/000314074.
10. Matsushima Y, Jones RL, King EG, et al. Alterations in pulmonary mechanics and gas exchange during routine fiberoptic bronchoscopy. Chest 1984;86(2):184–188. DOI: 10.1378/chest.86.2.184.
11. Lindholm CE, Ollman B, Snyder JV, et al. Cardiorespiratory effects of flexible fiberoptic bronchoscopy in critically ill patients. Chest 1978;74(4):362–368. DOI: 10.1378/chest.74.4.362.
12. Antonelli M, Pennisi MA, Conti G, et al. Fiberoptic bronchoscopy during noninvasive positive pressure ventilation delivered by helmet. Intensive Care Med 2003;29(1):126–129. DOI: 10.1007/s00134-002-1554-5.
13. American Thoracic Society; American College of Chest Physicians. ATS/ACCP Statement on cardiopulmonary exercise testing. Am J Respir Crit Care Med 2003;167(2):211–77. DOI: 10.1164/rccm.167.2.211.
14. Gil HI, Choe J, Jeong BH, et al. Safety of endobronchial ultrasound-guided transbronchial needle aspiration in patients with lung cancer within a year after percutaneous coronary intervention. Thorac Cancer 2018;9(11):1390–1397. DOI: 10.1111/1759-7714.12846.
15. Chawla R, Dixit SB, Zirpe KG, et al. ISCCM guidelines for the use of non-invasive ventilation in acute respiratory failure in adult ICUs. Indian J Crit Care Med 2020;24(Suppl 1):S61–S81. DOI: 10.5005/jp-journals-10071-G23186.