Chapter 24
Non Invasive Mechanical Ventilation and Bronchoscopy

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Abbreviations

FOB Fiberoptic bronchoscopy
NIV Non-invasive ventilation

24.1 Introduction

Since its introduction in 1968 by Ikeda [1], fiberoptic bronchoscopy (FOB) has progressively evolved and improved. Nowadays FOB is an essential and widespread tool for diagnostic and therapeutic purposes in several clinical settings. FOB's usefulness in the management of pulmonary diseases is well established and the main clinical indications are summarized in Table 24.1.

Although it is considered a safe procedure, FOB may hide some pitfalls, especially in patients with respiratory failure and in spontaneous breathing [2]. A decrease of 10–20 mmHg in arterial oxygen partial pressure usually occurs after uncomplicated bronchoscopies [3]. Furthermore, to make FOB's performance easier and to minimize patient's discomfort during the procedure, sedatives are often

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Table 24.1 Main indications to fiberoptic bronchoscopy in critically ill patients (Modified by Ref. [2])

Indication to fiberoptic bronchoscopy in critically ill patients
Airway aspiration
Airway bleeding
Airway assessment (e.g. acute inhalation injury, burns, trauma, tracheoesophageal fistula)
Airway management (e.g. difficult tracheal intubation, percutaneous tracheostomy, tracheal tube/double-lumen tube correct positioning evaluation, bronchial blocker insertion)
Airway stenosis
Atelectasis
Infections

administered [4]. Thus, in patients with limited respiratory function, performing FOB may be hazardous. Nevertheless, if such procedure is deemed indicated for the management of the patient, the clinician must balance risks and benefits of performing bronchoscopy. One promising strategy to enhance safety is performing FOB during non-invasive ventilation [5, 6].

This chapter will show, through a clinical case, the feasibility of awake fiberoptic-guided tracheal intubation during non-invasive ventilation.

Clinical Case

A 66-year-old woman, with a history of smoking, mild chronic obstructive pulmonary disease and obstructive sleep apnea treated with nocturnal continuous positive airway pressure presented to the emergency department because of fever, cough and increasing dyspnea in the last week.

At hospital admission she was awake, collaborative, tachypneic (respiratory rate was 28 breaths per minute) and clearly dyspneic. Blood pressure was 150/80 mmHg, heart rate 105 bpm, SpO_2 83% in room air, reaching 85% with oxygen in reservoir mask. Body temperature was 38.3 °C. At physical examination of the chest, crackles were present in the left basal and right mid-basal portions. Chest radiography showed a consolidation in the right lower lung lobe with mild pleural effusion which was confirmed with lung ultrasound.

At arterial blood gas analysis, pH was 7.32, pO_2 58 mmHg, pCO_2 48 mmHg, HCO_3^- 26 mmol/L, base excess −0.9, lactate 1.8.

The patient was first treated with non-invasive ventilation. After 30 min of non-invasive ventilation (NIV) the patient was still tachi-dyspneic (respiratory rate was 26 breaths per minute), SpO_2 was 90% and arterial blood gas analysis showed pH 7.33, pO_2 65 mmHg, pCO_2 47 mmHg, HCO_3^- 26 mmol/L, base excess −0.8, lactate 1.9.

Because of the limited patient's improvement, awake fiberoptic-guided tracheal intubation and invasive mechanical ventilation was considered the appropriate strategy as the patient was known to have a history of difficult intubation. Moreover, being the patient hypoxemic, interrupting NIV during the procedure could have been harmful. Thus, awake tracheal intubation was performed during non-invasive ventilation thanks to a particular mask for NIV, called Janus (Biomedical, Florence,

Fig. 24.1 Fiberoptic-guided tracheal intubation during non-invasive ventilation

Italy). The Janus mask is a full-face mask made-up with two halves joined together by a hinge and with a hole in the middle that allows the insertion of any kind of probe for procedures like bronchoscopy into patients' mouth or nose (Fig. 24.1) [7].

Before proceeding with intubation, a continuous infusion of low-dose remifentanil (0.05 mcg/kg/min) was started to achieve minimal sedation. The fiberscope with the tracheal tube embedded was inserted through the Janus hole and advanced into patient's airways till the trachea was reached. The tracheal tube was then left in place, the fiberscope removed and the patient deeply sedated and mechanically ventilated. During the procedure the patient remained stable with no hypotension nor desaturation observed.

24.2 Conclusions

There are several clinical scenarios in which the possibility to perform procedures like transesophageal echocardiography, upper gastrointestinal endoscopy or fiberoptic bronchoscopy during NIV would be desirable. This is particularly true in patients with acute respiratory distress and indication to NIV in whom endoscopy is deemed necessary for diagnostic or therapeutic purposes.

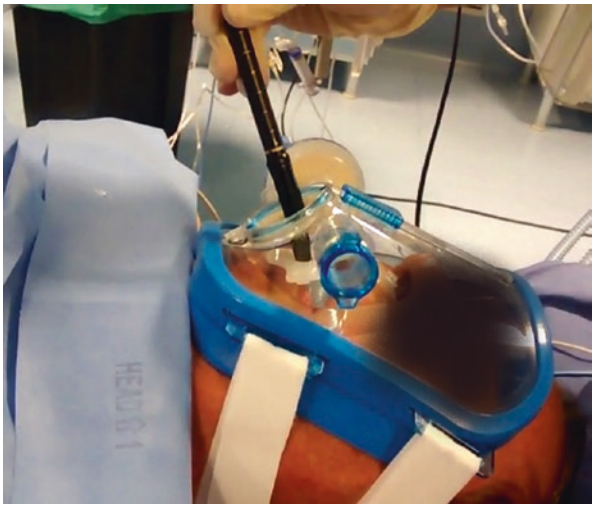

Fig. 24.2 Transesophageal echocardiography during non-invasive ventilation

Nowadays new available interfaces for NIV, like the Janus mask used in the clinical case described above in this chapter, allow simultaneously NIV and upper endoscopic procedures (Fig. 24.2) [8]. This may reduce respiratory complications.

Key Teaching Points

- Upper endoscopic procedures like bronchoscopy, gastrointestinal endoscopy or transesophageal echocardiography might be hazardous in patients with acute respiratory failure without advanced airway management
- The possibility to perform upper endoscopy during non-invasive ventilation might reduce procedure-related respiratory complications
- It is now possible to perform upper endoscopic procedures during NIV thanks to novel interfaces like the Janus mask

Questions and Answers

1. After an uncomplicated bronchoscopy, arterial oxygen partial pressure normally:

   (a) Does not change from its pre-procedural value
   (b) Increases 20–30% above baseline
   (c) Decreases by approximately 10–20 mmHg below baseline

   Answer: (c) Decreases by approximately 10–20 mmHg below baseline

2. In which of the following scenarios would you not perform bronchoscopy?

   (a) $PaO_2 < 90$ mmHg
   (b) $PaO_2 < 85$ mmHg
   (c) $PaO_2 < 75$ mmHg

   Answer: (c) $PaO_2 < 75$ mmHg

3. Which of the following statements is not correct?

   (a) Bronchoscopy may be performed in patients receiving non-invasive ventilation, without interrupting the ventilatory support
   (b) Non-invasive ventilation may not be applied to a patient who is already undergoing bronchoscopy, without interrupting the procedure
   (c) Fiberoptic-guided tracheal intubation may be performed during non-invasive ventilation, without interrupting the ventilatory support

   Answer: (b) Non-invasive ventilation may not be applied to a patient who is already undergoing bronchoscopy, without interrupting the procedure
4. While performing bronchoalveolar lavage in a ventilated patient, how much is the loss of tidal volume during each suctioning period?
   (a) 200–300 mL
   (b) 10–20 mL
   (c) 50–100 mL

   Answer: (a) 200–300 mL

References

1. Ikeda S, Yanai N, Ishikawa S. Flexible bronchofiberscope. Keio J Med. 1969;17:1–16.
2. Kabadayi S, Bellamy MC. Bronchoscopy in critical care. BJA Educ. 2017;17:48–56.
3. 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;162:1063–7.
4. Du Rand IA, Blaikley J, Booton R, et al. British Thoracic Society guideline for diagnostic flexible bronchoscopy in adults: accredited by NICE. Thorax. 2013;68(Suppl 1):i1–i44.
5. Esquinas A, Zuil M, Scala R, et al. Bronchoscopy during non-invasive mechanical ventilation: a review of techniques and procedures. Arch Bronconeumol. 2013;49:105–12.
6. Pieri M, Cabrini L, Landoni G. Preventing intubation-related cardiac arrest in ICU: a promising new ventilation mask. Crit Care Med. 2018;46:e715.
7. Bove T, Votta CD, Ciriaco P, et al. Bronchoscopy during non-invasive ventilation in a patient with acute respiratory distress syndrome. Signa Vitae. 2017;13:103–4.
8. Zangrillo A, Mazzone P, Votta CD, et al. Prolonged transesophageal echocardiography during percutaneous closure of the left atrial appendage without general anesthesia: the utility of the Janus mask. Can J Anaesth. 2016;63:962–5.