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Prevention of hypoxemia during endobronchial ultrasound-guided transbronchial needle aspiration: Usefulness of high-flow nasal cannula

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ABSTRACT

Background: Hypoxemia during endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) is often encountered even in patients without respiratory impairment before the procedure. The aim of this study was to evaluate the efficacy of a high-flow nasal cannula (HFNC) in preventing hypoxemia during EBUS-TBNA.

Methods: The present investigation was designed as a prospective pilot study. Eligible subjects were adults who could undergo EBUS-TBNA under intravenous midazolam sedation. The main exclusion criteria were as follows: age > 80 years with impaired oxygenation and peripheral oxygen saturation (SpO_2) < 95% at room air. The primary outcome was the oxygenation level during the procedure. Cutaneous carbon dioxide tension ($PcCO_2$) and complications were evaluated as secondary outcomes. HFNC use was started at an inspired O_2 fraction of 30% and was titrated to maintain SpO_2 over 90%. The lowest SpO_2 values during EBUS-TBNA were retrospectively compared between patients who underwent HFNC and those were given a conventional nasal cannula as a historical control group.

Results: Twelve patients received HFNCs. The mean lowest SpO_2 during the procedure was 93%. Although the mean SpO_2 tended to decrease in the early stages, it remained over 90% throughout the procedure. The mean highest $PcCO_2$ was 39 mmHg (range, 30–46 mmHg).

Abbreviations: BMI, Body mass index; CPAP, Continuous positive airway pressure; DBP, Diastolic blood pressure; EBUS-TBNA, Endobronchial ultrasound-guided transbronchial needle aspiration; FiO_2, Fraction of inspired oxygen; HFNC, High-flow nasal cannula; HR, Heart rate; $PcCO_2$, Cutaneous carbon dioxide tension; SBP, Systolic blood pressure; SpO_2, Peripheral oxygen saturation

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There were no major complications. In patients who underwent EBUS-TBNA using a conventional nasal cannula, the mean lowest SpO_2 was 88%, which was significantly lower than that in the HFNC cases ($p = 0.005$).

Conclusion: HFNC could be an effective and safe device for prevention of hypoxemia during EBUS-TBNA.

1. Introduction

Bronchoscopy is an indispensable diagnostic procedure in the current practice of respiratory medicine. During bronchoscopic procedures, oxygen supplementation should be used to achieve an oxygen saturation of at least 90% to reduce the risk of significant arrhythmia [1]. Intravenous sedation is now commonly used to reduce patient discomfort during bronchoscopy [2,3]. Although conventional oxygen support is provided during bronchoscopy, hypoxemia is often encountered during the procedure. In fact, the mean lowest peripheral oxygen saturation (SpO_2) during bronchoscopy under midazolam sedation has been reported to be less than 90% [4,5]. Hypoxemia during bronchoscopy under sedation is a condition that requires attention.

The high-flow nasal cannula (HFNC) is a novel device for oxygen administration, and its usefulness in some clinical conditions has been reported [6–9]. Recently, some authors have reported the usefulness of HFNC in bronchoscopy in patients with pre-respiratory failure [10,11]. However, to our knowledge, there has been no report that focused on the usefulness of HFNC in preventing hypoxemia during bronchoscopy. Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) is widely used for the diagnosis of mediastinal lesions and hilar lymph nodes, and desaturation is one of the most common complications during EBUS-TBNA [12]. In this study, we prospectively assessed the usefulness of HFNC for prevention of hypoxemia during EBUS-TBNA.

2. Materials and methods

2.1. Study subjects and design

We designed a prospective pilot study to evaluate the usefulness and safety of HFNC during EBUS-TBNA (UMIN000029967). Eligible subjects were adults ($\geq$ 20 years) with mediastinal or hilar lesions that were considered accessible by EBUS-TBNA. Exclusion criteria were age $>$ 80 and $<$ 18 years; presence of acute respiratory or cardiovascular disease; impaired oxygenation (SpO_2 $<$ 95% at room air); regular use of benzodiazepine-related drugs; and dementia. The primary outcome was the lowest SpO_2 during EBUS-TBNA. Secondary outcomes included peak cutaneous carbon dioxide tension ($PcCO_2$); changes in cardiovascular parameters [systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR)] from baseline; and procedure-related complications. This study was performed at Nagoya City University Hospital from October 2014 to December 2014. Informed consent was obtained from each patient and the study was approved by the Nagoya City University Hospital Ethics Committee (approval number: 1028, approval date: Sept. 17, 2014).

2.2. Procedures and measurements

An ultrasound bronchoscope and a dedicated ultrasound processor were used, while needle aspiration was performed with a 22-gauge needle (BF-UC260F-OL8, EU-ME1, and NA-201SX-4022, respectively; Olympus, Tokyo, Japan). The procedure was performed by 3 operators (HI, OT, and TU) who had more than 5 years of experience of EBUS-TBNA.

Before starting the procedure, 5 mL of 2% lidocaine was sprayed to the pharynx and larynx. Midazolam (0.06 mg/kg) was then intravenously administered for induction of sedation; half of the induction dose was added as necessary. At the beginning of the procedure, HFNC (OptiFlow™ OPT543; Fisher & Paykel, Auckland, New Zealand) was started at a flow rate of 40 L/min and at a fraction of inspired oxygen (FiO_2) of 30%, which was titrated by increments of 10% depending on oxygen demand to keep SpO_2 over 90%. Each EBUS-TBNA procedure was performed based on the following protocol: 1 mediastinal/hilar lesion to be examined; 3 needle aspirations of the lesion; 10 to 30 needle passes during each aspiration.

A $PcCO_2$ monitor based on the following noninvasive method was used: the transcutaneous electrode was heated to 44 °C to dilate the capillary bed just below the skin and allow the transcutaneous electrode to measure the CO_2 that diffused through the skin. The following procedure-related outcomes were registered on video recordings: SpO_2, $PcCO_2$, FiO_2, SBP, DBP, and HR. SpO_2 and FiO_2 values every 2 min from the start until the end of the examination were studied to observe the time courses of the parameters during the procedure. In the present study, complications were defined as pneumonia, mediastinitis, massive hemorrhage, respiratory failure requiring intubation, and other serious clinical conditions [13].

Specific terms were defined as follows: 1) pre-SpO_2, the SpO_2 value before starting the examination without oxygen supplement; 2) mean SpO_2, the average of SpO_2 measurements taken at 2-min intervals during the examination; 3) lowest SpO_2, the lowest SpO_2 value monitored during the examination; 4) highest $PcCO_2$, the highest $PcCO_2$ value monitored during the examination.

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