

Description of a New Procedure for Fiberoptic Bronchoscopy During Noninvasive Ventilation Through a Nasal Mask in Patients With Acute Respiratory Failure

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A new method is described for performing oral fiberoptic bronchoscopy during noninvasive ventilation through the nose. The technique was successfully applied in 2 patients suffering from acute respiratory failure. The bronchoscope was inserted through a glove finger fitted into a mouth guard. The system works as a valve and does not affect performance of the bronchoscopy procedure or the pressures administered during noninvasive ventilation. We conclude that the procedure has potential advantages over bronchoscopy through the nose and face masks or helmets, particularly for the management of secretions or in special clinical circumstances (hemoptysis or presence of foreign bodies). This method can be used to substitute for or complement other bronchoscopy techniques performed with other interfaces.

Key words: *Fiberoptic bronchoscopy. Noninvasive positive pressure ventilation. Nasal interface. Procedures.*

Descripción de un nuevo procedimiento para la realización de fibrobroncoscopia durante ventilación no invasiva mediante mascarilla nasal en pacientes con insuficiencia respiratoria aguda

Se describe un nuevo método para la realización de fibrobroncoscopia (FB) por vía bucal durante la administración de ventilación no invasiva por vía nasal, que se aplicó con éxito en 2 pacientes afectados de insuficiencia respiratoria aguda. La FB se realizó a través de una pieza de protección bucal a la que se adaptó un dedo de guante por dentro del cual se introdujo el fibrobroncoscopio. El sistema actúa como una válvula y no interfiere con las presiones administradas durante la ventilación no invasiva ni con los procedimientos broncoscópicos. Se concluye que el procedimiento presenta ventajas potenciales frente a la vía nasal por mascarilla facial o *helmet*, sobre todo en el manejo de secreciones o en circunstancias especiales (hemoptisis o cuerpo extraño), y permite alternar o complementar la FB practicada con otras interfaces.

Palabras clave: *Fibrobroncoscopia. Ventilación no invasiva con presión positiva. Ventilación no invasiva. Interfaz nasal. Procedimientos.*

Introduction

Noninvasive ventilation (NIV) is a first-line therapy in the treatment of patients with acute respiratory failure (ARF) as it obviates the need for orotracheal intubation and reduces a patient's stay in hospital.¹⁻⁴ ARF often arises from diverse etiologies with accompanying localized or diffuse pulmonary infiltrates^{5,6} or is complicated by the presence of secretions, thus requiring fiberoptic bronchoscopy for

diagnosis and treatment. Bronchoscopy itself can cause decreased oxyhemoglobin saturation (SaO_2), with reductions in PaO_2 of between 10 and 20 mm Hg⁷⁻⁹ and can lead to ARF or severe cardiac arrhythmias in patients with borderline gas exchange.

Studies have recently been published of small series of patients receiving nasal NIV who have undergone bronchoscopy through either face masks or helmets, with good results.^{10,11} Examination through the face mask or helmet, however, may have the disadvantages of difficulty of manipulation or the appearance of possible complications related to respiratory secretions or gastric contents.

We present a simple technique for performing bronchoscopy through the mouth that allows simultaneous delivery of NIV by nasal mask, without loss of effectiveness.

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Methods

For NIV, a BiPAP® bilevel positive airway pressure system (Respironics Inc, Morrisville, Pennsylvania, USA) was used in spontaneous/cycle mode and inspiratory and expiratory positive airway pressures (IPAP and EPAP) were adjusted independently in order to achieve effective ventilation (exhaled tidal volume, 10 mL/kg). In all cases, a minimum IPAP and EPAP of 14 and 5 cm H₂O, respectively, were used. The remote control unit was used to ensure that the administered pressures were kept steady during NIV. That digital system continuously monitors exhaled tidal volume, leaks, and IPAP/EPAP pressures. These pressures were adjusted as necessary during the procedure. A nasal mask (Respironics) with a chin strap connected to the sides of the mask's headgear was used to administer NIV.

Bronchoscopy was performed through the mouth with the aid of a mouth guard. The mouth guard was placed inside a latex glove which was then tied off using conventional suture material around the outer surface of the guard and a finger of the glove was left protruding from the central part. Once the glove had been tied off, the excess material was cut away and a small incision was made in the glove finger. Bronchoscopy was performed through this incision (Figure 1). The end result is a device which consists of a piece fitted to the mouth (mouth guard) and closed off by means of an elastic membrane that acts as a valve to retain pressure (essentially expiratory). A Fujinon EB250S® videobronchoscopy unit (Fujinon, Saitama City, Saitama, Japan) was used to perform the bronchoscopy and SaO₂ was monitored during the procedure using a Nonin 8600® pulse oximeter (Nonin Medical Inc, Minneapolis, Minnesota, USA).

Clinical Cases

Case 1

A 78-year-old man with a history of chronic obstructive pulmonary disease (COPD), sleep apnea, and smoking who was admitted to our department with a cough and progressive dyspnea (even at rest), general discomfort, irritability, inverted sleep rhythm and a mild fever that had developed over the previous 2 weeks. On arrival at the emergency department, the patient showed a diminished level of consciousness with asterixis, temperature of 37.7°C, blood pressure of 170/95 mm Hg, respiratory rate of 34 breaths per minute, heart rate of 120 beats per minute, acrocyanosis, and sweating. Auscultation of the lungs revealed generalized rhonchi and wheezes. No murmurs or abnormal heart noises were detected during auscultation. Arterial blood gas analysis on breathing ambient air showed a pH of 7.31, PaCO₂ of 68 mm Hg, PaO₂ of 47 mm Hg, bicarbonate (HCO₃) of 28, and SaO₂ of 86%, with a PaO₂/fraction of inspired oxygen (FiO₂) ratio of 218. A chest x-ray showed a mass of well-defined contours 3 to 4 cm in diameter in the left lower lobe, with accompanying alveolar infiltrate. Antibiotic treatment with cefotaxime and clarithromycin was initiated and the patient was administered bronchodilators and NIV using BiPAP® by nasal mask (IPAP, 14 cm H₂O; EPAP, 6 cm H₂O), and oxygen at 6 L/min. There was an improvement in the



Figure 1. Device for performing bronchoscopy through the mouth during administration of noninvasive ventilation using a nasal mask. Mouth guard prepared using a glove finger, through which the bronchoscope is passed.



Figure 2. Performing bronchoscopy through the mouth device while administering noninvasive ventilation through a nasal mask.

blood gases in the first few hours (PaO₂/FiO₂: 280), although the patient remained dependent on NIV throughout his stay in hospital and showed a deterioration of the blood gases on administration of conventional oxygen therapy using a Venturi mask during rest periods. When diagnostic bronchoscopy was required, it was performed using the method described above without interrupting NIV at any time (Figure 2). SaO₂ was 93% at the beginning of the procedure 95% at the end, and was never observed to fall below 90% at any time. The PaO₂/FiO₂ ratio remained unchanged at the end of the procedure. No significant variation in the administered pressures was observed, except during coughing fits, and pressure adjustment was not

required. Bronchoscopy revealed purulent secretions and signs of inflammation but no endobronchial damage was observed. Culture of the protected brush catheter produced growth of *Haemophilus influenzae*, sensitive to cefotaxime and the bronchoscopy aspirate showed the presence of malignant cells indicative of epidermoid carcinoma. The patient was released after 10 days. The NIV was removed on day 8 following improvement of clinical symptoms and blood gases.

Case 2

A 58-year-old woman with no relevant medical history of interest, admitted to the intensive care department for ARF secondary to severe bilateral pneumonia. A chest x-ray showed multiple bilateral diffuse alveolar infiltrates. She was referred to the pneumology department for urgent bronchoscopy to obtain samples for culture. The patient remained septic on the third day of antibiotic treatment and was administered NIV using BiPAP® at 16 and 5 cm H₂O IPAP and EPAP, respectively. The arterial blood gas analysis prior to bronchoscopy and under NIV showed a pH of 7.33, PaO₂ of 57 mm Hg, PaCO₂ of 43 mm Hg, HCO₃ of 17, SaO₂ of 90%, and a PaO₂/FiO₂ ratio of 195. Bronchoscopy was performed under NIV using the method described, after switching the patient to a nasal mask. Multiple points of thick, purulent secretions were observed in both primary bronchi. The left lower lobe contained a mucous plug that was easily aspirated and the bronchoscope was withdrawn on 2 occasions to facilitate its expulsion by coughing. The procedure was performed without incident and the patient had an SaO₂ of 94% upon completion. The administered pressures did not have to be adjusted during the procedure. Ventilation by face mask was reinstated following bronchoscopy. Culture of the bronchial aspirate and the protected brush catheter showed growth of 10⁴ colony-forming units of *Streptococcus salivarius*, sensitive to cefotaxime and clarithromycin. The patient was transferred to the pneumology department 3 days later and was discharged 15 days after admission.

Discussion

NIV is the treatment of choice for ARF in patients with COPD.²⁻⁴ Furthermore, there is evidence of its efficacy in ARF secondary to other causes, such as in immunodepressed patients (malignant blood diseases, solid organ transplants, and acquired immune deficiency syndrome), pneumonias, acute pulmonary edema, adult respiratory distress syndrome, and trauma.^{5,6,12,13} In these cases, NIV has made it possible to reduce orotracheal intubation and its attendant complications, shorten stays in intensive care, and reduce mortality. Although a face mask was used as the interface for most of the series, a new helmet interface for applying NIV has recently appeared. The helmet has shown the same effectiveness as the face mask in

patients with ARF from different causes and in immunodepressed patients. The helmet also increases patient tolerance and alleviates the complications associated with the administration of NIV.^{14,15}

Early etiological diagnosis in patients with severe pneumonia (whether community-acquired or nosocomial) makes choosing the correct antibiotic easier and can improve the outcome. For this reason, bronchoscopy with sampling (protected brush catheter and/or bronchoalveolar lavage) is an important diagnostic tool. There are contraindications for performing bronchoscopy in nonintubated patients, however; examples are hypoxemia (FiO₂>50%, required to maintain a PaO₂ of 75 mm Hg⁷). It is known that PaO₂ falls by between 10 and 20 mm Hg during bronchoscopy, so hypoxemic patients are at considerable risk of developing ARF.⁷⁻⁹ There were traditionally 2 options for these patients: either to intubate in order to perform bronchoscopy with invasive ventilation or to avoid bronchoscopy and apply empirical antibiotic treatment. In recent years, however, it has become possible to perform diagnostic bronchoscopy under NIV in patients with ARF from a variety of causes^{10,11,16} and in patients with COPD where it was contraindicated under spontaneous ventilation,¹⁷ and to perform intubation via bronchoscopy.¹⁸ Most studies have been carried out using a face mask connected to the ventilator^{10,16} and attached to the patient by elastic straps, with a T-adaptor on the mask for introducing the bronchoscope and, more recently, through the helmet by means of an adaptor.¹¹

Of note among these studies is that of Antonelli et al.¹⁶ In a prospective, randomized trial they compared NIV and oxygen therapy with a Venturi mask in 26 patients, all of whom had a PaO₂/FiO₂ ratio of 200 or less and suspected nosocomial pneumonia. The patients all required bronchoscopy with bronchoalveolar lavage. In the group receiving NIV via a face mask, the PaO₂/FiO₂ ratio increased by 82%, whereas it fell by 10% in the group receiving conventional oxygen therapy. Furthermore, the NIV group had a higher PaO₂/FiO₂ ratio 60 minutes after bronchoscopy and showed greater hemodynamic stability. The authors concluded that, in patients with severe hypoxemia, NIV is superior to conventional oxygen therapy and prevents deterioration in gas exchange during bronchoscopy. In a recent study of patients with ARF and suspected pneumonia who received NIV through a helmet and who required bronchoscopy with bronchoalveolar lavage, the procedure was performed through the helmet in pressure support mode with good tolerance. The method also prevented deterioration of gas exchange without requiring intubation at any point.¹¹

Our method allows patients receiving nasal ventilation to undergo bronchoscopy through the mouth in a noninvasive manner and without interfering with IPAP or EPAP. Performing bronchoscopy through the mouth has many potential advantages:

1. Bronchoscopy can be performed while maintaining continuous ventilation, without the need for adaptors or for changing the mask, which suffers no damage.

2. Secretions can be handled rapidly through the mouth. Likewise, the bronchoscope can be removed rapidly without damaging the nasal passage, which is often deteriorated in these patients due to prior manipulation, nasal catheterization, facial trauma, or pressure sores.

3. Bronchoscopy through the mouth under NIV avoids the danger of gastric content aspiration, which can happen in patients ventilated through helmets or face masks.

4. The technique can be applied in cases of aspiration of foreign bodies, aspiration of mucous plugs, or in the presence of threatened hemoptysis—circumstances that require frequent extraction of the bronchoscope. It also allows for rapid intubation if the patient deteriorates rapidly.

5. It is an easily reproducible method and can be extended to various hospital departments (emergency, pneumology, intensive care) without the need for complex or expensive systems.

The above notwithstanding, given the multiple problems that arise with the interfaces in patients with ARF, the different methods of performing bronchoscopy are considered to be complementary rather than exclusive and can be alternated just as the interfaces are alternated. We conclude that bronchoscopy can be performed through the mouth during application of nasal NIV in patients with ARF, thus preventing the patient from deteriorating without sacrificing treatment effectiveness.

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