CASE REPORT

Fibroscopy in patients with hypoxemic respiratory insufficiency: Utility of the high-flow nasal cannula

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Summary
We report the first case of a patient with severe acute respiratory failure who underwent fibrobronchoscopy with oxygen administration provided by high-flow nasal cannula.

We present the case of a patient with severe myasthenia gravis who was admitted to the Department of Intensive Care Medicine of our hospital with severe acute respiratory failure. The muscle weakness inherent to the patient’s underlying condition made expectoration of respiratory secretions difficult and led to the development of bilateral atelectasis. Non-invasive mechanical ventilation sessions were established, but there was no significant clinical improvement; hence, oxygen administration by humidified high-flow nasal cannula (Optiflow®, Fisher & Paykel, New Zealand) was decided. The patient experienced a subjective improvement, a decrease in respiratory rate, and an improvement in oxygenation, which, following appropriate premedication, allowed diagnostic—therapeutic bronchoscopy to be performed at bedside, without requiring endotracheal intubation or mechanical ventilation for the procedure.

The improvement experienced by the patient with high-flow nasal cannula, following appropriate premedication, allowed diagnostic—therapeutic bronchoscopy to be performed. © 2008 Elsevier Ltd. All rights reserved.

Introduction

Myasthenia gravis (MG) is an autoimmune disease characterized by fluctuating weakness of the skeletal musculature. The condition progresses to severe acute respiratory failure requiring Intensive Care Unit (ICU) admission and mechanical ventilation in 15–27% of cases.1,2 Patients with MG can present with alveolar hypoventilation and difficulty for expectoration, with subsequent accumulation of secretions and development of pulmonary atelectasis.1
Fibrobronchoscopy (FBS) is a procedure commonly used for diagnosing respiratory diseases (Fig. 1). There are several indications for this examination in critical patients, ranging from simple diagnosis of respiratory tract or pulmonary parenchyma disease to therapeutic measures, such as endotracheal tube placement or aspiration of secretions. Nonetheless, the technique is associated with a series of risks, such as hemorrhage, cardiac arrhythmia, bronchospasm, pneumothorax, pneumomediastinum, transient hypoxemia, and respiratory infection. When a technique such as FBS is carried out in hypoxemic patients breathing spontaneously, the hypoxemia can be exacerbated, making the technique intolerable and requiring endotracheal intubation (ETI) and mechanical ventilation. For this reason, the use of FBS is sometimes limited.

Recently, a method was described in which high-flow oxygen is delivered through a nasal cannula with an active humidification system that optimizes oxygen administration in adult patients with acute respiratory failure (ARF). Although there are no published reports of its use in FBS, it is reasonable to believe that the system could be useful in such procedures. The high-flow nasal cannula (HFNC) has been tested in healthy volunteers, in stable chronic obstructive pulmonary disease (COPD) patients, and in patients who have undergone abdominal surgery. We report the first case of a patient with severe ARF who underwent FBS with oxygen administration provided by HFNC.

Clinical case report

A 32-year-old woman, smoker, with a history of bronchial asthma showing no decompensations, and hypothyroidism secondary to thyroidectomy at the age of 15 for Graves–Basedow disease. In May 2007, the patient experienced flu-like symptoms with acute respiratory failure requiring ETI. She was diagnosed with type V MG (positive antibodies to acetylcholine receptors [AChR]) and underwent a percutaneous tracheostomy for prolonged mechanical ventilation.

The patient was scheduled for admission to our center for elective surgical resection of the thymus, which was carried out with no intraoperative incidents. Following surgery she received 2 g iv of metamizole (no known allergies) and during the postoperative, she presented with generalized skin pruritus, tachypnea, and labored breathing with progressive hypoxia. Treatment was started with bronchodilators, corticoids, and pyridostigmine and she was admitted to the ICU for severe ARF.

At the time of ICU admittance, the patient was conscious, oriented, and afebrile. She was hemodynamically stable with blood pressure at 125/85 mmHg and heart rate at 80 bpm in sinus rhythm. She showed resting tachypnea of 25 respirations per minute (rpm), signs consistent with bronchospasm on auscultation and severe hypoxemia with a PaO2/FIO2 ratio of 62 mmHg. The analytical parameters were within normal limits with the exception of leukocyte count at 15,600 × 10⁶ cells/L (84% neutrophils). Treatment with beta-mimetic drugs, corticoids, and pyridostigmine was maintained, and antibiotic treatment was started, based on suspected exacerbation of the neuromuscular disease secondary to an underlying infectious process. Because of the severity and progression of respiratory failure, she was given additional immunosuppressive therapy (FK-506) and immunoglobulins (28 g) for 5 days.

Initially, the patient was administered oxygen therapy with a Venturi mask (VM) and flow 12–15 Lpm of oxygen. Physiotherapy was started, N-acetyl-cysteine (Mucofluido® MÉSNA) was given to facilitate expectoration of bronchial secretions and non-invasive mechanical ventilation (NIV) sessions were initiated. Nevertheless NIV was bad tolerated and oxygen administration by humidified HFNC (Optiflow™, Fisher & Paykel, New Zealand) was established at 40–50 Lpm and FIO2 1. HFNC use resulted in a subjective improvement in the sensation of dyspnea perceived by the patient, a decrease in the respiratory rate (28 rpm with VM vs. 19 rpm with HFNC) and improved oxygenation after only 30 min of use (PaO2/FIO2 with VM: 128 mmHg vs. PaO2/FIO2 with HFNC: 235 mmHg).

After 72 h of hospitalization, respiratory failure persisted despite all the measures and treatments applied. A decision was made to perform FBS within the ICU; the patient was conscious and breathing spontaneously (HFNC at 40 Lpm and FIO2 1). Before the procedure, she was given 1 mg intravenous (IV) atropine, and mild sedation–analgesia with 0.15 mg IV fentanyl, 140 mg IV propofol, 15 mg IV midazolam, and remifentanil IV perfusion at 6 μg/kg/min. The procedure lasted approximately 15 min and the patient was hemodynamically stable and showed SpO2 ≥90% throughout. Arterial blood gas values were pH 7.33, pO2 121 mmHg, and pCO2 68.5 mmHg before FBS, and pH 7.54, pO2 106 mmHg, and pCO2 39 mmHg following FBS. Fibrobronchoscopy disclosed the presence of abundant thick, purulent respiratory secretions obstructing the middle—lower right and lower left bronchi. Bronchoalveolar lavage was performed and samples were taken for microbiological study. No microorganisms were isolated.

Following FBS there was a transient clinical improvement but a left basal atelectasis persisted at the chest X-ray (Fig. 2). Subsequently, the patient again showed labored breathing, muscle fatigue, and alveolar hypoventilation that ultimately required ETI and NIV. She was administered immunoglobulins, the pyridostigmine dose was reduced because of abundant bronchorrhea, nebulized DNase (Pulmocyn, rhDNA, Genetech) was initiated to facilitate

![Figure 1](image.png) Chest X-ray before the first fibrobronchoscopy procedure.
elimination of respiratory secretions, and two new FBS were performed to treat recurrent atelectasis in the left lung base. She showed gradual clinical improvement, was extubated, and at 13 days of hospitalization, was discharged (Fig. 3).

Discussion

Myasthenia gravis is an autoimmune disease associated with an AChR deficit at the neuromuscular junction, characterized by muscle weakness and fatigue that are exacerbated by activity and partially improves with rest. It mainly affects women 20–40 years of age. The disease is classified into different grades (I–V) according to the extension of the manifestations and is often associated with other autoimmune conditions, particularly those affecting the thyroids. The diagnosis of MG is based on detection of anti-AChR antibodies in plasma, electrophysiologic evidence of alterations in neuromuscular transmission with repeated stimuli, and/or improvements in muscle weakness with administration of anti-cholinesterase agents (edrophonium test). The disease has an unpredictable clinical course, generally marked by periods of exacerbation and remission.

Patients with MG are admitted to the ICU when they present, or are at risk of presenting with a myasthenic crisis, which is defined as a severe aggravation of muscle weakness with respiratory failure requiring ETI or postponement of extubation beyond 24 h after surgery. In addition to treatment with anti-cholinesterase drugs, immunosuppressors, immunoglobulins, and plasmapheresis, mechanical ventilation remains an essential support measure in the severe respiratory failure these patients develop, secondary to alveolar hypoventilation and accumulation of secretions. Pulmonary atelectasis is a common complication, and when it persists, can lead to worsening of the preexisting hypoxemia and the development of respiratory infection.

Therefore, early use of an examination such as FBS may be indicated. Nonetheless, there is an (undocumented) impression among intensive care specialists that the use of certain techniques, such as FBS, can be limited in spontaneously breathing patients with severe hypoxemia because of the risk that ETI and mechanical ventilation may be needed.

The high-flow oxygen treatment has been previously used for neonates. Now, it is available for adult patients. It consists of a device that combines a nasal cannula with an active humidification system to allow administration of highly humidified, high-flow oxygen (Optiflow, Fisher & Paykel, New Zealand). The high-flow delivery decreases dilution of the inhaled oxygen, and the considerable humidification may facilitate elimination of secretions. In a recent study conducted in our center comparing HFNC with the VM, we found that in patients given oxygen via HFNC, PaO2/FI,O2 improved and respiratory rate decreased without changes in the pH or PaCO2. In addition, a subjective assessment of the device was performed and patients reported milder oral mucosa dryness and greater comfort as compared to the VM.

The improvement in oxygenation seen in patients using HFNC can be explained by several factors. First, nasal cannulas made of a well-tolerated material are used instead of conventional nasal–buccal masks. Second, administration of high-flow oxygen may decrease dilution with room air by more completely satisfying the patient’s inhalational flow demand. Third, high-flow administration may decrease the dead space (wash-out effect). In addition, a possible flow-dependent effect with continuous positive airway pressure (CPAP) has been documented in healthy volunteers and in patients with COPD. Lastly, the use of high humidity levels may prevent changes in the pseudostratified ciliated epithelium of the airways, maintain mucociliary system activity, facilitate elimination of secretions, reduce atelectasis formation, and thereby, indirectly improve oxygenation. In addition, the respiratory rate is lower in patients receiving oxygen through HFNC, a fact that may result in better tolerance to exercise.

We believe that HFNC is likely to have an increasingly important role in facilitating the practice of certain invasive procedures in hypoxemic patients. The value of this technique was illustrated in the patient reported herein, who remained stable and showed acceptable oxygenation during the entire endoscopy procedure. This excellent tolerance can be explained, at least in part, by the optimized oxygen supply she received, supported by correct premedication. Administration of drugs such as atropine, which helps to decrease bronchial secretions and prevents bradycardia and bronchoconstriction, as well as mild

Figure 2 Chest X-ray after the first FBS.

Figure 3 Chest X-ray at intensive care unit discharge.
sedation—analgesia, which decreases anxiety, facilitates collaboration, and produces an amnesic effect, make FBS more comfortable for the patient. Nonetheless, the technique should always be performed by an expert fibrobronchoscopy operator in these cases.

However this case has one limitation. The duration of the respiratory failure before FBS could decrease its effectiveness, indeed in the case of this patient FBS was perfectly tolerated but she finally needed ETI due to excessive fatigue. Therefore, the possible benefits of early use of HFNC on the outcomes of these patients remain uncertain.

**Conclusion**

In summary, the importance of this clinical case is to bring to the clinician’s attention the potential value of this new technique for oxygen administration, which made feasible the practice of a diagnostic and therapeutic procedure that otherwise might not have been tolerated or might have required prior ETI and mechanical ventilation. HFNC could be especially beneficial for obtaining lower respiratory tract samples in patients who are difficult to diagnose, thereby avoiding the risks of ETI. Lastly, in light of the highly favorable tolerance to FBS with the use of HFNC, early application of this examination can be considered in patients with respiratory failure, and this would avert the need for ETI, as was ultimately required in the patient reported.

**Conflict of interest statement**

None of the authors have a conflict of interest to declare in relation to this work.

**References**