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Ann. Acad. Med. Siles. (online) 2025; 79: 231–236
eISSN 1734-025X
DOI: 10.18794/aams/208880
www.annales.sum.edu.pl

OPIS PRZYPADKU
CASE REPORT

High-flow nasal oxygen therapy used to facilitate bronchofiberoscopy in high-risk patients not qualified for urgent bronchofiberoscopy procedure

Wysokoprzepływowa tlenoterapia donosowa stosowana w celu ułatwienia wykonania bronchofiberoskopii u pacjentów wysokiego ryzyka niekwalifikujących się do pilnej bronchofiberoskopii

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ABSTRACT

The case series illustrates clinical challenges associated with performing fiberoptic bronchoscopy (FOB) on patients with severe respiratory and cardiovascular diseases. Standard respiratory support methods may be insufficient or may pose risks in this population. The first case involved a patient with a congenital heart defect, unstable hemodynamics, and suspected inflammatory changes in the lungs who required diagnostic FOB due to bleeding from the respiratory tract. Use of high-flow nasal oxygen therapy (HFNOT) allowed for safe performance of FOB, minimizing the risk of barotrauma-related complications. The second patient was diagnosed with Melnick-Needles syndrome, chronic respiratory failure and bronchial cartilage chondromalacia, which can be responsible for complications during standard FOB. HFNOT was also used during the procedure, which prevented complications resulting from anatomical limitations and barotrauma. These cases suggest that HFNOT is an effective alternative to traditional respiratory support methods during FOB for patients at a high risk of complications, especially those with congenital heart defector airway anomalies.

KEYWORDS

barotrauma, respiratory failure, bronchofiberoscopy, non-invasive ventilation support

Received: 26.06.2025 **Revised:** 01.08.2025 **Accepted:** 01.08.2025 **Published online:** 22.08.2025

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Publisher: Medical University of Silesia, Katowice, Poland

STRESZCZENIE

Seria przypadków klinicznych ilustruje wyzwania związane z wykonaniem bronchofiberoskopii (*fiberoptic bronchoscopy* – FOB) u pacjentów obciążonych kardiologicznie i pulmonologicznie. Standardowe metody wsparcia oddechowego mogą być niewystarczające u tej grupy pacjentów. Pierwszy przypadek dotyczy pacjentki z wrodzoną wadą serca, niewydolnością oddechową i podejrzeniem zmian zapalnych w płucach, wymagającej diagnostycznej FOB z powodu krwioplucia. Zastosowanie wysokoprzepływowej tlenoterapii donosowej (*high-flow nasal oxygen therapy* – HFNOT) pozwoliło na bezpieczne wykonanie FOB, minimalizując ryzyko powikłań związanych np. z barotraumą. Drugi przypadek dotyczy pacjentki ze zdiagnozowanym zespołem Melnicka i Needlesa, przewlekłą niewydolnością oddechową i chondromalacją chrząstki oskrzelowej, co mogło stanowić przyczynę powikłań podczas standardowej FOB. W trakcie zabiegu również zastosowano HFNOT, co zapobiegło powikłaniom wynikającym z ograniczeń anatomicznych i ewentualnej barotraumy. Opisane przypadki kliniczne mogą sugerować, że zastosowanie HFNOT u pacjentów z wysokim ryzykiem powikłań, zwłaszcza z wrodzoną wadą serca i anomaliami dróg oddechowych, jest skuteczną alternatywą dla tradycyjnych metod wsparcia oddechowego.

SŁOWA KLUCZOWE

barotrauma, niewydolność oddechowa, bronchofiberoskopia, nieinwazyjne metody wsparcia oddechowego

INTRODUCTION

Fiberoptic bronchoscopy (FOB) remains an important diagnostic and therapeutic method in pulmonology, but its use in patients with advanced respiratory failure and comorbidities associated with a high risk of complications requires particular caution. Choosing an appropriate method of respiratory support during the procedure, especially in patients with anatomical anomalies of the respiratory tract or circulatory system, is important for ensuring patient safety and the effectiveness of the examination. This paper presents two clinical cases – a patient with cyanotic heart disease and a patient with Melnick-Needles syndrome – in whom FOB was performed using high-flow nasal oxygen therapy (HFNOT) as an alternative to non-invasive mechanical ventilation (NIV). The case reports illustrate the complexity of management in situations where conventional treatment methods may not be possible or carry a risk of serious complications, and highlight the potential role of HFNOT in enabling safe bronchoscopy in high-risk patients.

CASE REPORTS

Case 1

A 34-year-old female patient with a cyanotic congenital heart defect was admitted to the Department of Pulmonary Diseases due to hemoptysis. For about a week, she had been expectorating about 150 ml of bloody sputum. She visited the ear, nose, and throat (ENT) emergency department twice, where inflammation or other possible sources of bleeding in the upper airway region were ruled out.

The patient's medical history indicated pulmonary atresia with ventricular septal defect (PA-VSD) coexisting with a right aortic arch. Blood was supplied to the pulmonary circulation via collateral circulation originating from the aorta. During infancy, the patient underwent a Blalock-Taussig systemic-pulmonary shunt as part of cardiac surgery treatment which was closed in the patient's first year of life.

Laboratory tests have shown signs of polycythemia, with a hemoglobin concentration of 22 g/dL, which was a decrease from previous results. Saturation measurements showed oxygen saturation of 75%. This was confirmed by blood gas analysis, which also showed signs of type 1 respiratory failure. No increase in inflammatory markers was found.

Due to hemoptysis and a cardiological history, a decision was made to perform a computed tomography (CT) angiography of the pulmonary arteries. Imaging confirmed the presence of a ventricular septal defect and a right-sided aortic arch; however, the pulmonary artery could not be visualized. Other vascular abnormalities included primary branches originating from the aortic arch and additional sources of arterial vascularization from the descending aorta, which connected to the network of pulmonary collateral vessels leading to segmental pulmonary vessels on both sides. No signs of embolism were found in any of the visualized vascular structures.

Numerous infiltrative-atelectatic changes were revealed in the lung parenchyma, with the greatest intensity in the lower lobe of the left lung. Additionally, there were 'ground glass' opacities and a *cobblestone pattern*, as well as signs of bronchial obstruction caused by secretions. The complete radiological image indicated that the changes in the lung parenchyma were inflammatory in nature.

The results of the diagnostic tests suggested a potential inflammatory cause of the hemoptysis. In the context of an uncorrected heart defect, this carried a significant risk of progression to massive hemoptysis with accompanying hemodynamic instability. For this reason, the patient was urgently referred for FOB to confirm the infection, isolate the causative agent, and control the bleeding locally.

Considering the patient's chronic respiratory failure resulting from a cyanotic heart defect and the presence of numerous anastomoses, various potential respiratory support options were considered. The presence of a left-to-right shunt disqualified the patient from the classic oxygen therapy through oxygen cannulas. Despite the use of relatively high flow rates, in the range of 6–8 l/min, peripheral blood saturation and arterial blood gas parameters did not change significantly. Other possible methods of respiratory support were HFNOT or NIV. As of today, there are no clinical studies conducted on large groups of patients directly comparing these two techniques in the specific situation of our patient. Nevertheless, there is a lot of indirect data available on various heart defects in patients after cardiac surgery due to heart defects. A direct comparison of HFNOT and NIV in pediatric patients after cardiac surgery indicates a lower risk of intubation in patients treated with HFNOT, but the choice of technique does not affect postoperative pO_2 and pCO_2 [1,2].

Similarly, in the pediatric patients who have underwent correction of a congenital heart defect, HFNOT, compared to respiratory support methods requiring the use of a mask, reduces the risk of desaturation and the need for mechanical ventilation [3]. On the other hand, NIV is the recommended treatment for patients with respiratory failure in the course of acute circulatory failure [4].

FOB did not reveal any signs of potential inflammation. Bloody secretions originating from the left main bronchus were observed in the bronchial tree. The entire mucosa from the trachea level was covered with numerous dilated vessels (Figure 1 and Figure 2). The source of the bleeding was a vessel located within the mucosa of the left main bronchus. The bleeding site was lavaged with cold saline limiting the bleeding.

The patient was transferred to a cardiology center to assess the possibility of performing vascular procedures or cardiac surgery.

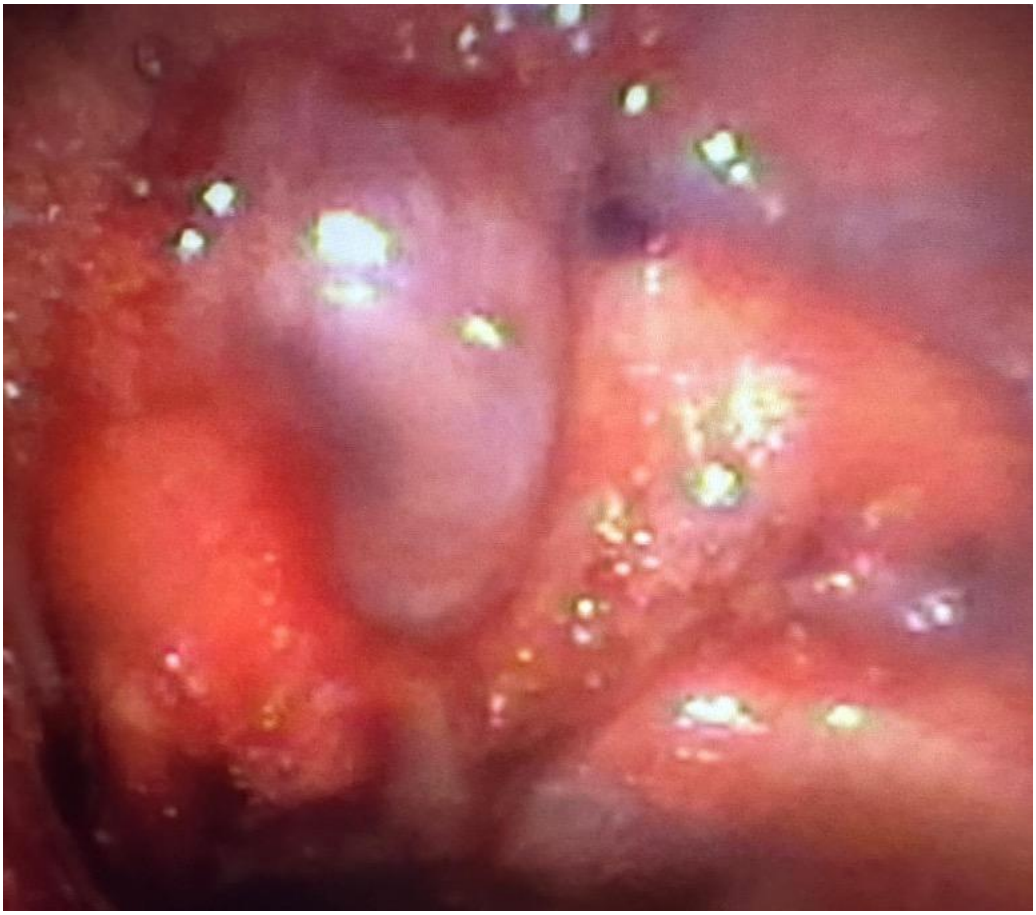

Fig. 1. Vascular malformations visible during bronchoscopy procedure.

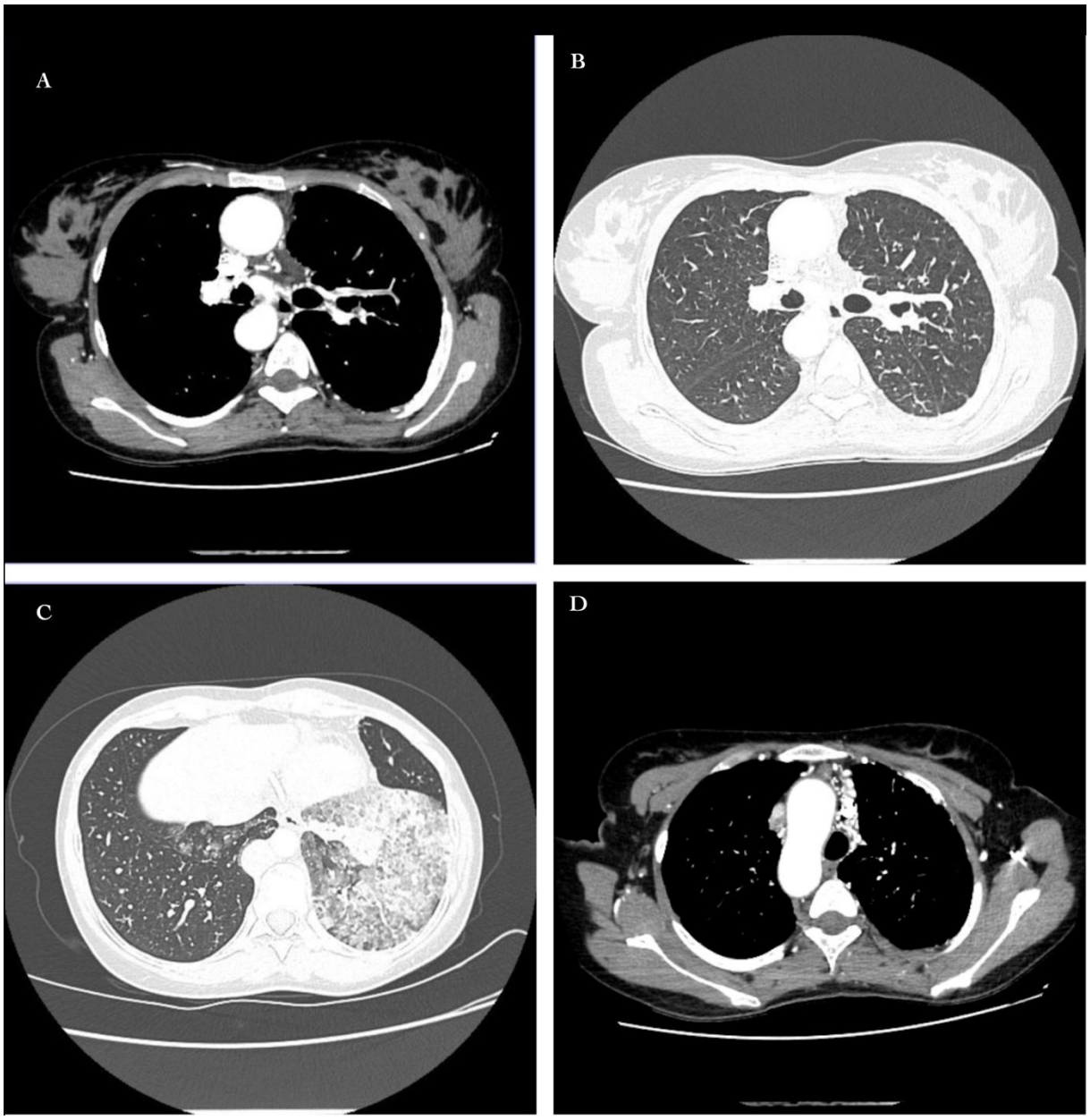

Fig. 2. A – Numerous collateral and additional pulmonary vessels – mediastinal window; B – Numerous collateral and additional pulmonary vessels – pulmonary window; C – Ground-glass opacities and infiltrations in left lower lobe; D – Web of additional vessels originating from descending aorta.

Case 2

A 21-year-old female patient with Melnick-Needles syndrome, height 1.45 m, weight 30 kg, was admitted to the Department of Pulmonary Diseases for a diagnostic and therapeutic bronchoscopy, as there was a suspicion of secretion retention due to massive bronchiectasis. Melnick-Needles syndrome is a very rare osteochondrodysplasia caused by mutations in the *FLNA* gene, which encodes filamin A. Patients with this condition typically have unusual facial features, ribs and long bones deformities and scoliosis. More severe cases are associated with respiratory failure secondary to the chest wall abnormalities [5,6].

Due to the size of the respiratory tract (diameter of the trachea estimated at 10 mm and main bronchi at 7 mm based on chest CT scan), the patient was disqualified from FOB at other tertiary care clinics.

On May 20–22, 2025, the patient was hospitalized in the Clinical Department of Internal Medicine, Pneumology and Allergology 4th Military Clinical Hospital in Wroclaw due to a reported desaturation < 80% SpO_2 during physical activity and an increasing sensation of secretion retention in the respiratory tract over the previous month. The patient has previously been treated with azithromycin and clindamycin without clinical improvement. The patient has been undergoing nasal oxygen therapy at home at a flow

rate of 1 L/min for a month. For the last five years, the patient has also been treated with NIV due to chronic respiratory failure.

The patient's medical history included medical observation for pulmonary hypertension following AH1N1 pneumonia in 2013, but no invasive diagnostic procedures were performed. The patient's medical history also includes surgical correction of the mandible due to micrognathia in 2021.

A chest CT scan on May 21, 2025, revealed skeletal abnormalities, areas of ground glass opacity and heterogeneous lung parenchyma density, as well as thoracic kyphoscoliosis and progression of peribronchial consolidations. An attempt to perform spirometry was unsuccessful.

A decision was made to perform interventional bronchoscopy using HFNOT to reduce the risk of barotrauma associated with high inspiratory pressures applied during NIV.

Bronchoscopy was performed under local anesthesia using lidocaine spray and analgo-sedation. The initial HFNOT settings were 40 L/min, FiO_2 = 40%, temperature 37°C. After inserting the bronchoscope, a reduction of SpO_2 to 86% was noted, most likely due to effect of benzodiazepine on the respiratory drive. Therefore, the HFNOT settings were adjusted to a flow rate of 60 L/min and FiO_2 of 50%. As hypoxemia persisted, the settings were further increased to flow rate of 70 L/min and FiO_2 of 100%, which enabled safe bronchoscopy without respiratory distress throughout the procedure.

During the procedure, features of chondromalacia and mucosal oedema were visible in the bronchi of the left lung. During suctioning, the bronchial lumen collapsed. Numerous fragments of deformed sub-segmental cartilages were visible in the lobar and segmental bronchi, bulging into the lumen of the respiratory tract. In the right lung bronchi, mainly in the main, lobar and segmental sections, numerous fragments of deformed bronchial cartilage were visible, bulging into the airway lumen. Material was collected for histopathological, bacteriological and mycological examination. Arterial blood gas analysis performed after bronchoscopy revealed: pH = 7.38, PO_2 84 mmHg, PCO_2 49 mmHg and saturation 98%.

Notably, a standard adult-sized bronchofiberoscope was used during the procedure, which allowed for the assessment of subsegmental bronchi openings. We conclude that the measurements of the bronchi and trachea based on CT were underestimated due to their collapse caused by cartilage defects in the course of Melnick-Needles syndrome.

DISCUSSION

Bronchoscopy is becoming an increasingly common procedure for patients with respiratory failure. In patients with severe or impending respiratory decompensation, exacerbations of respiratory failure can occur, which pose a risk to the patient's life. In cases of advanced respiratory failure, respiratory support in the form of invasive or non-invasive mechanical ventilation is necessary. When selecting a support method, it should be taken into account that airway resistance increases to the fourth power of the radius (Hagen–Poiseuille law).

Therefore, anatomical changes leading to airway stenosis may pose a risk of barotrauma or hypoventilation, which may result in respiratory acidosis and exacerbation of respiratory failure due to the generation of high positive pressure during invasive or non-invasive mechanical ventilation.

In both cases, positive airway pressure may cause complications such as bleeding or hemorrhage from the respiratory tract. In patient 1, there was also a risk of significant hypotension resulting from circulatory failure. In patient 2, the risk was caused by potential barotrauma and/or hypoventilation. Inducing turbulent flow and flushing out the anatomical dead space with HFNOT allowed the procedure to be performed safely in both cases.

However, NIV is important for patients with respiratory failure requiring bronchoscopy, and the respiratory support technique can usually be chosen based on blood gas analysis [7].

Furthermore, a meta-analysis revealed that the use of NIV after cardiac surgery in adults has no effect on the incidence of cardiac and pulmonary complications or intubation rates [8], which contrasts with the aforementioned pediatric study [3].

In special situations, the anatomical conditions of the respiratory tract, as well as conditions resulting from the size and capacity of the circulatory system – which may be disturbed by excessive chest pressure – will require the use of respiratory support methods that are not primarily based on the severity of initial respiratory failure and the required respiratory support, but on the risk of complications associated with comorbidities.

The use of HFNOT may enable safe bronchoscopy in high-risk patients, who would otherwise be disqualified from this procedure.

When using a bronchoscope, the external diameter is 5.4 mm in adults and 3 mm in children, while the biopsy

channel diameter is 3.0 mm in adults and about 1.0 mm in children, which significantly limits the working channel and diagnostic possibilities. Furthermore, introducing a larger bronchoscope into the respiratory tract during respiratory support, considering the Hagen–Poiseuille law, requires higher pressure to ensure the proper ventilation of the patient. This increases the risk of complications, such as barotrauma, particularly in patients with anatomical airway narrowing. Using HFNOT, we were able to perform the examination on patients who were initially disqualified due to the risk of exacerbating respiratory failure, thus avoiding complications such as barotrauma.

Prospective randomized studies are necessary to determine precise indications for selecting the optimal form of respiratory protection for high-risk patients requiring FOB.

Announcement

We obtained written consent from both patients for publication of the clinical case.

Conflict of interest

There was no conflict of interest.

Financial disclosure

The research was performed as a part of the Medical University of Silesia grant No. BNW-1-105/N/5/K.

Authors' contribution

Study design – A. Oraczewska, M. Zieliński, S. Skoczyński, I. Zielińska-Leś
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Final approval of the version to be published – A. Oraczewska, M. Zieliński, S. Skoczyński, I. Zielińska-Leś

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