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CASE REPORT

Extracorporeal membrane oxygenation-facilitated palliative radiotherapy for severe airway obstruction due to lung cancer: A case report

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Abstract

Background: The use of venovenous extracorporeal membrane oxygenation (VV-ECMO), particularly during radiotherapy, for severe malignant central airway obstruction has rarely been reported.

Case Presentation: A 47-year-old female presented to our emergency department with severe respiratory distress. Given her medical history, she was initially diagnosed with asthma. Despite initial treatment, which included intubation, her condition deteriorated, necessitating VV-ECMO. Computed tomography performed following the initiation of VV-ECMO revealed extensive lung cancer involving both bronchial types. Radiotherapy while on VV-ECMO led to a significant reduction in tumor size, allowing for the weaning of ECMO support and successful extubation.

Conclusion: Malignant central airway obstruction is life-threatening. Our case demonstrates the efficacy of combining VV-ECMO with radiotherapy when conventional therapies fail. Further research is necessary to validate and explore this novel approach's implications.

KEYWORDS
lung cancer, malignant central airway obstruction, radiotherapy, severe respiratory distress, venovenous extracorporeal membrane oxygenation

INTRODUCTION

Central airway obstruction (CAO) impedes airflow in crucial lower respiratory tract segments, including the trachea, main stem bronchi, bronchus intermedius, and lobar bronchus.[1] Malignancies, particularly lung cancer, often compromise these airways.[1,2] Tracheal tumors can be inconspicuous on chest radiographs, with detection rates below 30%.[2,3] Symptoms typically manifest when tumors obstruct over half of the tracheal diameter.[4] Given the limited window for early detection, untreated malignant CAO (MCAO) has a poor prognosis, with an average survival of 1–2 months. Asphyxiation and mechanical ventilation often ensue.[5]

Historically, MCAO treatments, especially when surgery is unfeasible, relied on bronchoscopic interventions and palliative radiotherapy.[6] Conventional treatments such as airway stenting have limitations and potential complications.[6–8] Palliative radiotherapy is often the sole solution to alleviate obstruction,[5] with a need for careful respiratory management. Venovenous extracorporeal membrane oxygenation (VV-ECMO), usually for acute respiratory failure, is gaining traction for severe airway problems. Its application, especially during radiotherapy for severe MCAO, is scarcely documented.[8–10]

We report a case of a 47-year-old female with MCAO owing to small-cell lung carcinoma, demonstrating the novel application of VV-ECMO with radiotherapy, a rarely explored pairing.

CASE PRESENTATION

A 47-year-old female with intermittently managed asthma owing to self-discontinued clinic visits was taken by ambulance to the emergency department in severe respiratory and orthopneic distress. Initially, her oxygen saturation measured 61% on ambient air. Vital signs showed blood pressure of 137/98 mmHg, heart rate of 120 beats per minute, respiratory rate of 50 breaths per minute, oxygen saturation of 68% on 5 L/min of supplemental oxygen, and a Glasgow Coma Scale score of 10. During the physical examination, bilateral chest auscultation revealed wheezing. Heart sounds were normal, and there was no evidence of lower extremity edema. Despite treatment with a beta-stimulant inhaler and intramuscular adrenaline, the patient's condition did not improve. Subsequently, owing to decreased consciousness, intubation was performed, followed by administration of magnesium sulfate and corticosteroids. A continuous infusion of adrenaline and ketamine was also initiated. Chest radiography showed no clear abnormalities; although the carina was indistinct, the tracheal tube tip was appropriately positioned (Figure 1A).

Despite pressure-controlled ventilation, respiratory acidosis persisted, with arterial CO_2 partial pressure surging from 96.8 to 180.6 mmHg within 90 min. To address this, femoral-jugular VV-ECMO commenced alongside rocuronium for paralysis and propofol for sedation. Intravenous heparin maintained an activated partial thromboplastin time of 60–100 s. With ECMO blood flow at 2.8 L/min, arterial CO_2 concentration significantly decreased (Figure 2).

Computed tomography (CT) revealed a large mediastinal mass compressing and infiltrating the carina and both bronchi, causing complete left main stem bronchus occlusion (Figure 1C). Endobronchial stent placement was unsuccessful owing to severe airway compression (Figure 1B). Preliminary pathology confirmed limited-stage small-cell lung carcinoma. Given the concerns about inadequate local control and potential infections from immunosuppression post-chemotherapy, we discontinued this method. Despite safety reservations about radiotherapy and possible disruption by breathing efforts, we implemented a 39 Gy radiotherapy regimen over 13 sessions (3 Gy each), beginning on the second hospital day, with adjustments to the ECMO circuit for safety (Figure 3A). CCTV monitored the radiotherapy

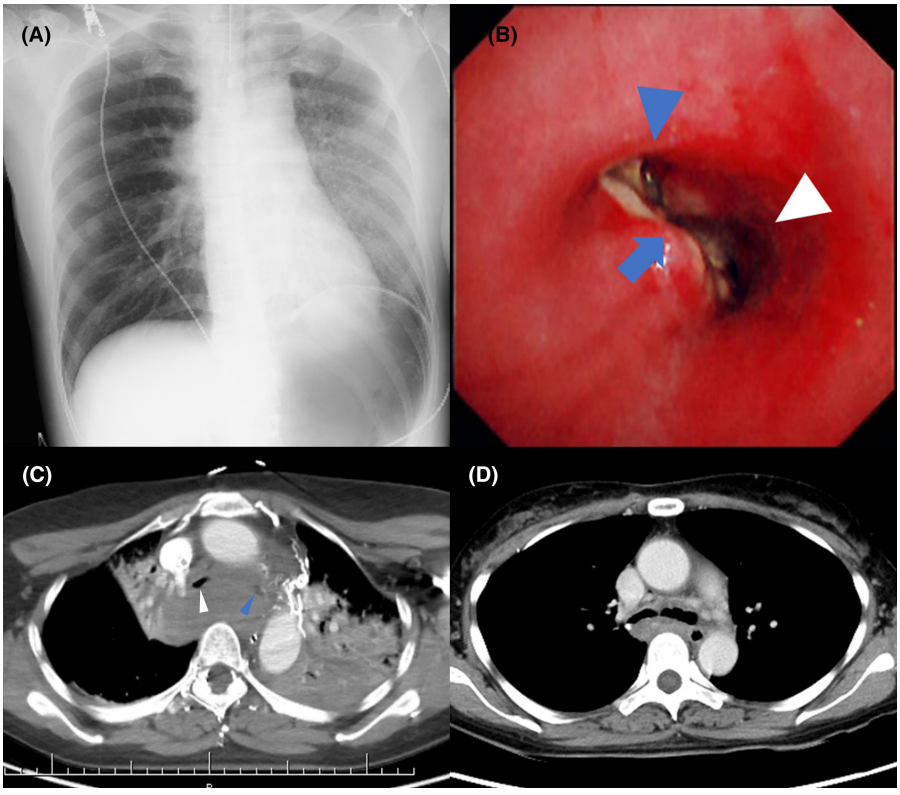

FIGURE 1 Chest radiography (A) does not clearly reveal any abnormalities at first glance. Although the carina appears indistinct, the positioning of the tip of the tracheal tube seems to be appropriate. However, closer inspection reveals a decrease in transparency of the left lung and a mild leftward mediastinal shift, suggestive of left lung atelectasis. Furthermore, there is an absence of the radiolucent image of the airways originating from the carinal bifurcation extending into both bronchi. Additionally, the left diaphragm is elevated. Bronchoscopic findings on the day of admission (B). Infiltration and compression of the carina (a blue arrow), right main bronchus (a white arrowhead), and left main bronchus (a blue arrowhead) by the lung tumor. We attempted to place an endobronchial stent falter owing to severe airway compression and infiltration. Chest computed tomography (CT) on the day of admission (C) shows a large mediastinal mass compressing the carina and both main stem bronchi. The tumor's compression and infiltration have rendered the carina indistinct. The right main bronchus (a white arrowhead) is significantly stenotic, and the left main bronchus (a blue arrowhead) is obstructed. Furthermore, a consolidation is observed in the dorsal region of the left lung caused by the obstruction of the left main bronchus. Subsequent CT following radiotherapy (D) showed a reduction in the tumor size, with decreased compression of the carina and both main stem bronchi.

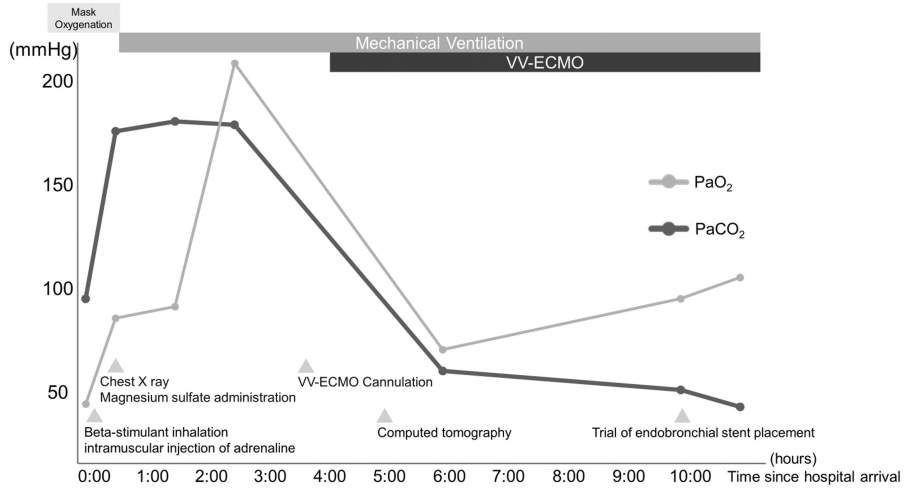

FIGURE 2 Clinical time course on the first day of hospitalization. Inhalation of beta-stimulants and intramuscular injections of adrenaline were ineffective, necessitating intubation. As the arterial CO_2 partial pressure continued to increase, venovenous extracorporeal membrane oxygenation was initiated. Attempts to place a stent were unsuccessful.

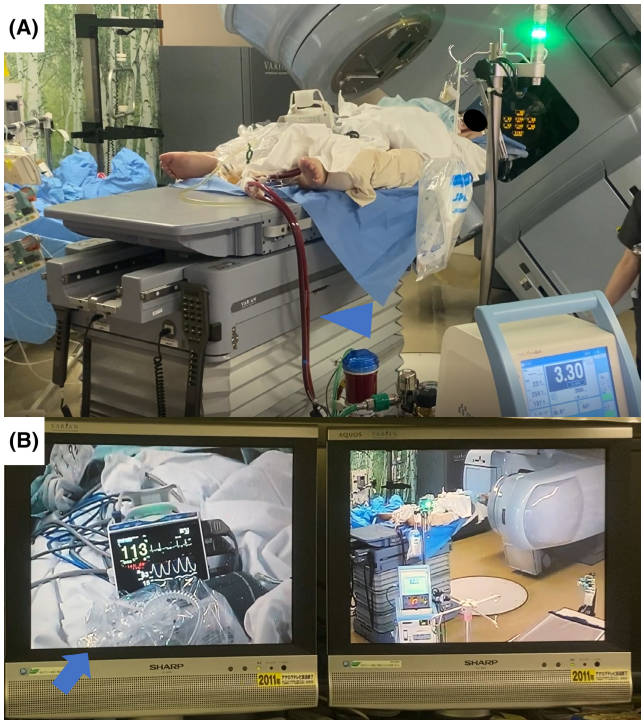

FIGURE 3 Points of ingenuity in radiotherapy under venovenous extracorporeal membrane oxygenation (VV-ECMO). (A) Extended ECMO circuit and (B) closed-circuit television (CCTV). We adjusted the length of the ECMO circuit (a blue arrowhead) and monitored the patient during the radiotherapy using CCTV (a blue arrow).

(Figure 3B), and muscle relaxants were used to suppress spontaneous breathing and ensure effective tumor irradiation.

On hospital day 12, bronchoscopy and CT scans showed substantial tumor reduction (Figure 1D). By hospital day 15, ECMO support was successfully weaned, and the patient was extubated and discharged from intensive care 4 days post-extubation. Subsequently, four cycles of adjuvant chemotherapy were commenced to consolidate recovery. Despite these efforts, she succumbed to widespread cancer metastasis 8 months later.

Informed consent was obtained from the patient to publish this case report and accompanying information.

DISCUSSION

Our case reveals two key findings in managing severe MCAO in small-cell lung carcinoma. First, a strategic treatment regimen, including VV-ECMO, can rescue patients from life-threatening MCAO conditions. Second, administering radiotherapy during VV-ECMO with meticulous monitoring is feasible and potentially lifesaving.

Managing CAO, especially from malignancies, presents an intricate clinical dilemma. Conventional strategies such as surgery are often not feasible, compelling clinicians to explore alternatives such as bronchoscopic interventions[6–8] or chemotherapy to reduce tumor burden. However, these interventions have limitations. Stent migration, stent obstruction by secretions, and risk of massive bleeding can preclude the use of bronchoscopic interventions.[6,7] Furthermore, the delayed onset of efficacy associated with chemotherapy may render it ineffective in cases of rapid deterioration of respiratory status.[8] In such cases, radiotherapy may be the only option for patient survival,[5] reinforcing emerging evidence supporting the role of VV-ECMO in managing respiratory failure caused by severe airway compression, particularly during ongoing therapeutic interventions.[8–10]

VV-ECMO during radiotherapy for MCAO is a promising, albeit under-documented, technique that enhances treatment precision and patient outcomes. Adjustments to the ECMO circuit, CCTV for continuous monitoring, and muscle relaxants stabilized the irradiation field, allowing radiotherapy without exacerbating respiratory issues, even in severe MCAO. This method provides sustained respiratory support, critical in MCAO, reducing the risk of acute

respiratory failure and treatment disruptions.[8–10] For treatment under VV-ECMO, the efficacy of chemotherapy remains uncertain owing to the potential for drug loss through the ECMO circuit. Furthermore, there is a risk of severe infections owing to bone marrow suppression.[8] Here, we decided not to use chemotherapy because of the uncertainty of its effects and concerns over infection.

The strength of this integrated treatment enhances radiotherapy regardless of the patient's respiratory status. However, its effectiveness varies by cancer type, with concerns about post-treatment bleeding.

Our findings hold significant clinical implications, demonstrating that even in severe MCAO cases, a combined strategy involving VV-ECMO and radiotherapy can markedly enhance outcomes. This method necessitates careful patient selection, strict monitoring, and a thorough grasp of its benefits and risks.

In conclusion, we adopted the novel VV-ECMO and radiotherapy combination as a palliative measure owing to limitations with standard treatments, underscoring its possible utility in treating complex conditions and in patients ineligible for alternative treatments. Further research is essential to ascertain its broader utility in enhancing MCAO outcomes.

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CONFLICT OF INTEREST STATEMENT

Dr. Takashi Moriya is an Editorial Board member of AMS Journal and a co-author of this article. To minimize bias, they were excluded from all editorial decision-making related to the acceptance of this article for publication.

DATA AVAILABILITY STATEMENT

For further information, contact the corresponding author.

ETHICS STATEMENT

Approval of the research protocol: Ethical approval was not required for this case report according to institutional and national guidelines.
Informed consent: Informed consent for publication was obtained from the subject.
Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.

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