Case Report

Successful difficult airway management with emergent venovenous extracorporeal membrane oxygenation in a patient with severe tracheal deformity: a case report

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Background: Difficult airway management is occasionally encountered in the emergency department, and recent studies suggest that extracorporeal membrane oxygenation can be useful in these cases.

Case Presentation: A 74-year-old man was transferred to our hospital due to worsening dyspnea. On arrival, it was found that he was in respiratory distress and was comatose. Arterial blood gas analysis showed severe hypercapnia and respiratory acidosis. Intubation could not be done because he had severe tracheal deformity due to cervical-thoracic kyphosis secondary to vertebral tuberculosis. Therefore, we carried out surgical tracheostomy under venovenous extracorporeal membrane oxygenation. The patient's oxygenation gradually improved, and extracorporeal membrane oxygenation was withdrawn on day 8. He was transferred to another hospital on day 46 and suffered no neurological deficits.

Conclusion: Severe tracheal deformity can result in a difficult airway. Extracorporeal membrane oxygenation is an effective life-saving approach in cases of difficult airway management due to severe tracheal deformity.

Key words: Difficult airway, extracorporeal membrane oxygenation, tracheal deformity, vertebral tuberculosis

INTRODUCTION

CRITICALLY ILL PATIENTS frequently require tracheal intubation for resuscitation in the emergency department. However, difficulties during advanced airway management are occasionally encountered in approximately 11% of all cases,[1] which can result in permanent harm or even death.[2] Extracorporeal membrane oxygenation (ECMO) has been used as a rescue strategy in the management of patients with cardiac and respiratory failure,[3] and a few recent reports have described its use for non-traditional indications, such as upper airway obstruction.[4–6] Here we report on the first case of difficult airway caused by severe tracheal deformity due to vertebral tuberculosis that was successfully resuscitated using ECMO.

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CASE REPORT

A 74-YEAR-OLD MAN (body height, 148 cm; body weight, 42 kg) presented with symptoms of the common cold for a few days and was transferred to our hospital due to worsening dyspnea. On arrival, his initial vital signs were as follows: Glasgow Coma Scale score, 6 (E1V1M4); respiratory rate, 18 breaths/min; percutaneous oxygen saturation, 94% under assisted ventilation with bag valve mask; heart rate, 84 b.p.m.; and blood pressure, 169/70 mmHg. He had weak breathing, and his oxygen saturation fell sharply when assisted ventilation was stopped. Results of arterial blood gas analysis revealed severe hypercapnia and respiratory acidosis (Table 1).

Based on the clinical presentation, we planned to intubate the patient for mechanical ventilation. However, tracheal intubation was extremely difficult because of severe cervical-thoracic kyphosis resulting from vertebral tuberculosis. First, we administered fentanyl i.v. and tried to intubate him by video laryngoscopy; although the glottis was easily visualized, we made one attempt at intubation with an endotracheal tube (ETT) with an internal diameter (ID) of 8.0 mm (outer diameter [OD] 10.9 mm), which was unsuccessful because the abnormal curvature of the trachea prevented

Table 1. Results of arterial blood gas of a 74-year-old man with severe tracheal deformity

	On admission†	After ECMO initiation‡	After tracheostomy‡
pH	6.789	7.142	7.274
pCO_2 (mmHg)	Unmeasurable	86.7	57.4
pO_2 (mmHg)	79.6	115	49.9
sO_2 (%)	81.5	97.3	84.0
HCO_3^- (mmol/L)	Unmeasurable	23.1	22.6
BE (mmol/L)	Unmeasurable	0.1	−0.3
Lactate (mmol/L)	3.2	3.3	4.0

BE, base excess; HCO_3^-, bicarbonate ion; pCO_2, partial pressure of carbon dioxide; pO_2, partial pressure of oxygen; sO_2, arterial oxygen saturation.
†Under assisted ventilation with bag valve mask
‡Extracorporeal membrane oxygenation (ECMO) blood flow, 3.0 L/min; sweep gas, 3.0 L/min; sweep FiO_2, 1.0.

tube advancement. Next, we attempted to intubate by bronchoscopy with a diameter of 5.9 mm but failed to advance the bronchoscope beyond the abnormal curve. Finally, we managed to intubate with an ETT with an ID of 5.0 mm (OD 6.9 mm). However, this provided inadequate ventilation; percutaneous oxygen saturation decreased to 70% and did not improve. Supraglottic airway devices were not used because the patient's neck was short and the range of neck motion was limited.

After the multiple failed attempts at ventilation by ETT, we judged that it was necessary to undertake a surgical tracheostomy to secure his airway. However, simple cricothyrotomy was not expected to resolve the issue of severe tracheal deformity (Fig. 1A). Additionally, surgical tracheostomy for severe tracheal deformity required time, but the patient lacked the oxygen capacity needed to maintain saturations while the procedure was carried out. Therefore, we decided to use venovenous ECMO for surgical tracheostomy. We chose the femoral–femoral configuration of venovenous ECMO because of the patient's short neck and limited neck motion. A 22 French gauge (Fr) drainage cannula (NSH heparin-coating cannula; Senko Medical Instrument Mfg., Tokyo, Japan) was placed percutaneously in the right atrium and the superior vena cava through the right femoral vein, and a 20 Fr return cannula (NSH heparin-coating cannula) was placed percutaneously in the inferior vena cava through the left femoral vein. Venovenous ECMO increased his percutaneous oxygen saturation to 90%, allowing a tracheostomy to be placed beyond the severe abnormal curve. We inserted the flexible spiral type of tube with an ID of 8.0 mm (GB Adjustfit Tracheostomy Tube; Fuji Systems, Tokyo, Japan). After tracheostomy, the patient was admitted to intensive care. A computed tomography scan after admission confirmed the presence of a severe tracheal deformity that was curved at a sharp angle (Fig. 1E,F). Lung rest ventilation was instituted for the duration of intensive care admission.

Based on the history of events and examination findings, we diagnosed the cause of the respiratory failure to be pneumonia and initiated a course of antibiotics. The patient's oxygenation gradually improved (Fig. 2), allowing ECMO to be withdrawn on day 8. Hypercapnic respiratory failure persisted due to the chest deformity, but intensive rehabilitation made it possible to wean him off the ventilator during the daytime. He was transferred to another hospital for continued rehabilitation on day 46 and had no neurological deficits.

DISCUSSION

THE PRESENT CASE highlights that severe tracheal deformity due to cervical-thoracic kyphosis can make it difficult to use a standard intubation protocol. However, when airway management is difficult, ECMO can be used as an effective life-saving approach.

Skeletal tuberculosis accounts for approximately 10% of cases of extrapulmonary tuberculosis, with the spine being the site most commonly affected.[7] Spinal deformity is a frequent consequence in these cases, with increases in kyphotic deformity of 10° or more seen in up to 20% of patients, even with appropriate treatment,[7] and 3%–5% developing kyphosis of 60° or greater.[8] The severe kyphotic deformity is particularly likely to cause tracheal deformity and hypercapnic respiratory failure,[9] but there have been no reports of inability to intubate as a consequence.

In the unanticipated difficult airway, a preplanned strategy for airway management could reduce the likelihood of adverse outcomes. The guidelines for difficult intubation from the Difficult Airway Society describe various advanced airway management options for use when tracheal intubation is unexpectedly difficult.[10] If the patient falls into the category "cannot intubate cannot ventilate," the final step is to perform a scalpel cricothyroidotomy. However, the use of ECMO is not described, despite being used successfully to manage cardiac and respiratory failure.[3] Recently, it has also been reported to be useful for hypoxic and/or hypercapnic patients with difficult airways (e.g., tracheal stenosis,

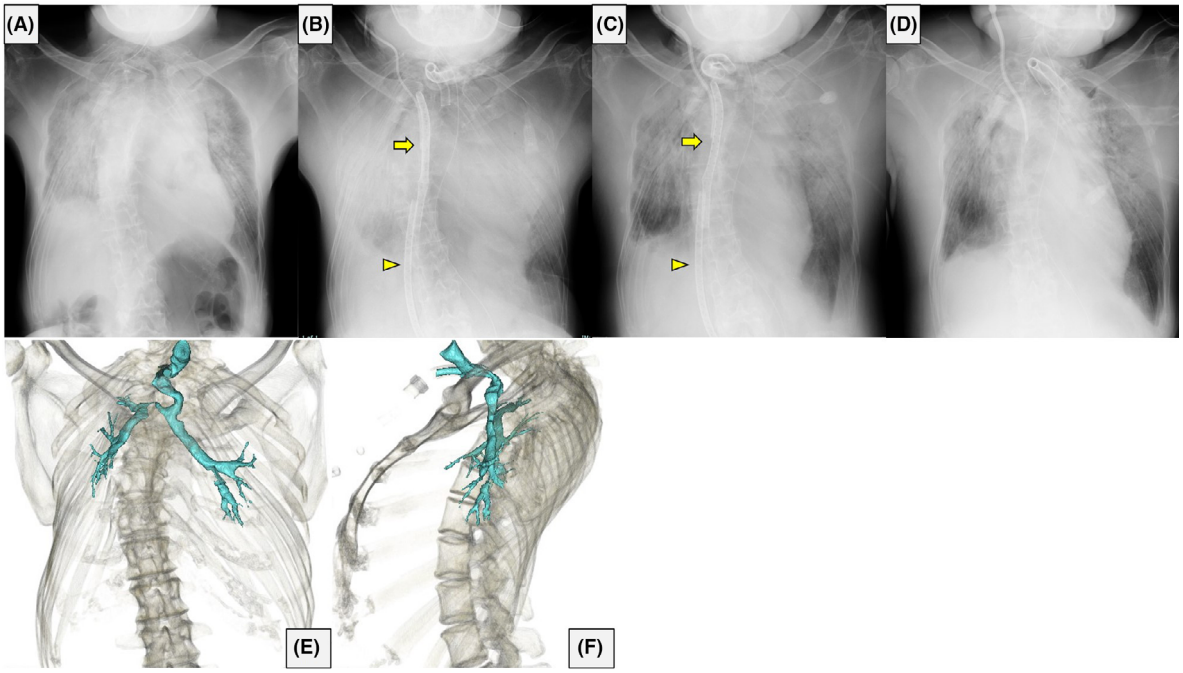

Fig. 1. Chest X-ray findings and 3-D reconstruction of thoracic computed tomography of a 74-year-old man with severe tracheal deformity. A–D, Chest X-ray findings from admission to extracorporeal membrane oxygenation weaning. The arrow indicates a drainage cannula, and the arrowhead indicates a return cannula. Lung consolidation improved gradually. A, On admission. B, After the operation. C, Day 4, D, Day 8. E, F, 3-D reconstruction of thoracic computed tomography. The trachea and bronchi are shown in blue. The trachea is deformed in both the anterior-posterior and lateral directions and the right main bronchus is highly stenosed due to thoracic vertebrae deformity. E, Anterior view. F, Left side view.

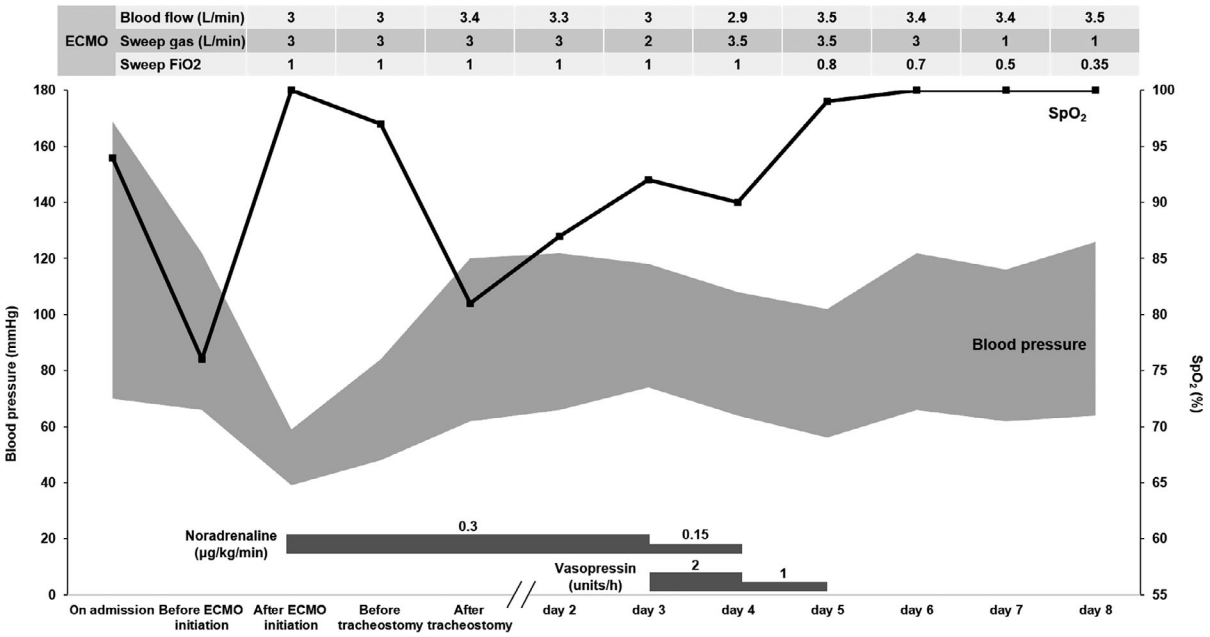

Fig. 2. Clinical course from admission to extracorporeal membrane oxygenation (ECMO) weaning of a 74-year-old man with severe tracheal deformity.

malignant tumor, and foreign body).[4–6] Although difficult airway management is an uncommon indication, ECMO could be used as rescue therapy in these patients. We were unable to undertake intubation and maintain oxygenation by standard methods in this case, and cricothyroidotomy was considered to introduce unacceptable risk because the extent of tracheal deformity was not fully known until later investigation. Therefore, we believe our choice to use venovenous ECMO provided optimal support during surgical tracheostomy.

CONCLUSIONS

VERTEBRAL TUBERCULOSIS CAN cause cervicalthoracic kyphosis and severe tracheal deformity, leading to the potential for difficult airway management. Our experience suggests that ECMO is an effective and life-saving approach when undertaking surgical procedures in patients for whom it is impossible to carry out intubation and maintain oxygenation by standard methods.

DISCLOSURE

APPROVAL OF THE research protocol: N/A.

Informed consent: The patient provided informed consent for publication of this case report.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

Conflicts of Interest: None.

REFERENCES

1 Sakles JC, Douglas MJK, Hypes CD *et al*. Management of patients with predicted difficult airways in an academic emergency department. J. Emerg. Med. 2017; 53: 163–71.

2 Cook TM, Woodall N, Harper J, Benger J. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: intensive care and emergency departments. Br. J. Anaesth. 2011; 106: 632–42.

3 Squiers JJ, Lima B, DiMaio JM. Contemporary extracorporeal membrane oxygenation therapy in adults: Fundamental principles and systematic review of the evidence. J. Thorac. Cardiovasc. Surg. 2016; 152: 20–32.

4 Yunoki K, Miyawaki I, Yamazaki K *et al*. Extracorporeal membrane oxygenation-assisted airway management for difficult airways. J. Cardiothorac. Vasc. Anesth. 2018; 32: 2721–5.

5 Malpas G, Hung O, Gilchrist A *et al*. The use of extracorporeal membrane oxygenation in the anticipated difficult airway: a case report and systematic review. Can. J. Anaesth. 2018; 65: 685–97.

6 Holliday T, Jackson A. Emergency use of extracorporeal membrane oxygenation for a foreign body obstructing the airway. Crit. Care Resusc. 2010; 12: 273–5.

7 Garg RK, Somvanshi DS. Spinal tuberculosis: a review. J. Spinal Cord Med. 2011; 34: 440–54.

8 Rajasekaran S. Kyphotic deformity in spinal tuberculosis and its management. Int. Orthop. 2012; 36: 359–65.

9 Shneerson JM. Respiratory failure in tuberculosis: a modern perspective. Clin. Med. 2004; 4: 72–6.

10 Frerk C, Mitchell VS, McNarry AF *et al*. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br. J. Anaesth. 2015; 115: 827–48.