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Case Report

Interventional lung assist and extracorporeal membrane oxygenation in a patient with near-fatal asthma[☆]

Abstract

Near-fatal and fatal asthma are uncommon but can be linked to severe complications and mortality. Extracorporeal circulation systems, such as interventional lung assist or extracorporeal membrane oxygenation, may be used in rescue therapies for these entities. We encountered a patient with near-fatal asthma who was rescued via early initiation of interventional lung assist and extracorporeal membrane oxygenation without severe complications.

A 47-year-old woman visited the emergency department (ED) for dyspnea 3 hours in duration and stuporous mental status. She was diagnosed as having asthma 20 years prior and used a salbutamol inhaler for relief only. She had no other medical comorbidities and smoking history.

On admission, the blood pressure was 178/114 mm Hg, heart rate was 100 beats/min, respiratory rate was 40 breaths/min, and body temperature was 37.2°C. Pulse oximetry showed 80% oxygen saturation. On auscultation, lung sounds could not be heard. Chest x-ray (Figure) revealed bilateral hyperinflation of the lungs and a narrow heart. On arterial blood gas analysis, partial pressure of carbon dioxide (Paco₂) and oxygen were 121 and 67 mm Hg with a pH of 6.97 and bicarbonate of 27 mmol/L, indicating respiratory acidosis.

Because of mental status deterioration and respiratory failure, endotracheal intubation was performed immediately after admission to the ED. However, mechanical ventilation (MV) could not be maintained because of extremely high airway pressure, and thus, airway integrity was maintained via manual ventilation with bag valve mask. Simultaneously, treatments of asthmatic exacerbation including inhaled short-acting β agonist, short-acting anticholinergic, systemic and inhaled corticosteroid, and epinephrine were administered. Although conventional treatments were conducted under deep sedation and muscular paralysis, Paco₂ remained elevated at 80 mm Hg. At the same time, partial pressure of oxygen recovered to 167 mm Hg.

We decided to apply pumpless interventional lung assist (iLA; Novalung GmbH, Hechingen, Germany) to eliminate CO₂. Oxygenation was acceptable under manual ventilation, and recovery of airway resistance was expected. The right femoral artery and left femoral vein were cannulated, and the iLA membrane was connected within 4 hours of ED admission. With the passage of arterial blood flow via the iLA membrane, gas exchange improved. The Paco₂ decreased to 48 mm Hg 1 hour after iLA implementation, and pH increased to 7.27 from 7.16.

The patient was stable with gas exchange under iLA and manual ventilation for 4 hours; however, obstruction of the iLA membrane by blood clot occurred.

We decided to apply pumped extracorporeal membrane oxygenation (ECMO) instead of changing the iLA membrane in the intensive care unit (ICU). Venovenous ECMO was initiated using a Permanent Life Support (PLS) system (Maquet Cardiovascular, Hirrlingen, Germany). Paco₂ and arterial pH were rapidly normalized. In addition, MV could be connected to the endotracheal tube with 30 cm H₂O of target plateau pressure. Although tidal volume was approximately 30 mL in pressure control ventilation mode, oxygenation was stable under venovenous ECMO. Tidal volume at the same target pressure increased to 240 mL within 12 hours of ECMO initiation. On the fourth ICU day, weaning from ECMO and MV was possible. She was transferred to the general ward on ICU day 5 and was released on hospital day 16.

Although fatal asthmatic episodes are uncommon, they do occur [1–3]. An extracorporeal circulation system has been implemented for near-fatal or fatal asthma in several cases [4–7]. However, specific recommendations regarding the type of system and the timing are not yet available. In this case, iLA was applied in the ED, and ECMO was applied in the ICU when airway resistance showed no signs of rapid release. Our patient with near-fatal asthma failed to respond to medical treatment and MV but recovered successfully via iLA and ECMO without complications.

Almost all reported cases of ECMO usage in near-fatal asthma exhibited complications of barotrauma on standard treatment before application of ECMO [8]. In recent cases reporting fatal complications before extracorporeal circulation, initiation of extracorporeal system ranged from 3 to 48 hours after admission [4,5,8]. Therefore, the appropriate timing for ECMO might be very early on in cases of fatal and near-fatal asthma to prevent complications such as barotrauma or arrest.

Recently, iLA, a pumpless device for extracorporeal arteriovenous CO₂ removal, was applied in hypercapnic respiratory failure and was reported to be a safer procedure than ECMO [9,10]. Although some investigators have reported the use of iLA in severe asthma [11], the severity of airway obstruction or air trapping before iLA was not obvious. However, the status of these patients fell within the acceptable tidal volume range from 200 to 350 mL on MV before iLA [6,11,12].

In patients in whom MV cannot be maintained because of extremely high airway pressure and longstanding manual ventilation is expected, such as our case, initial ECMO might be appropriate rather than iLA. The discontinuation of manual ventilation, causing inconsistent minute ventilation and lung injury, was adequate justification for switching from iLA to ECMO in our patient.

In conclusion, our case suggests the importance of very early initiation of extracorporeal circulation in the ED in cases of near-fatal asthma

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Figure. A chest radiograph shows bilateral hyperinflated lungs and a long narrow heart shadow.

unresponsive to conventional medical treatment and MV. The extracorporeal system can be selected based on arterial blood gas, airway pressure, and available tidal volume under MV, in addition to the hemodynamic status of the patient.

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References

- [1] Gonzalez-Barcala FJ, Calvo-Alvarez U, Garcia-Sanz MT, Bourdin A, Pose-Reino A, Carreira JM, et al. Characteristics and prognosis of near-fatal asthma exacerbations. *Am J Med Sci* 2015;350:98–102.
- [2] Bellido Casado J, Plaza V, Bardagi S, Cosano J, Lopez Vina A, Martinez Moragon E, et al. Is the incidence of near-fatal asthma decreasing in Spain? *Arch Bronconeumol* 2006;42:522–5.
- [3] Kao CC, Jain S, Guntupalli KK, Bandi V. Mechanical ventilation for asthma: a 10-year experience. *J Asthma* 2008;45:552–6.
- [4] Tiruvoipati R, Haji K, Gupta S, Braun G, Carney I, Botha J. Low-flow veno-venous extracorporeal carbon dioxide removal in the management of severe status asthmaticus: a case report. *Clin Respir J* 2014.
- [5] Iwamoto T, Ikeda K, Nakajima H, Suga M, Kumano K, Hiraguri M, et al. Extracorporeal membrane oxygenation is indicated for status asthmaticus refractory to maximal conventional therapy. *Ann Allergy Asthma Immunol* 2013;110:300–1.
- [6] Lee YS, Joo H, Moon JY, Huh JW, Oh YM, Lim CM, et al. A case of iLA application in a patient with refractory asthma who is nonresponsive to conventional mechanical ventilation: a case report. *Korean J Crit Care Med* 2012;27:108–10.
- [7] Kukita I, Okamoto K, Sato T, Shibata Y, Taki K, Kurose M, et al. Emergency extracorporeal life support for patients with near-fatal status asthmaticus. *Am J Emerg Med* 1997;15:566–9.
- [8] Leiba A, Bar-Yosef S, Bar-Dayyan Y, Weiss Y, Segal E, Paret G, et al. Early administration of extracorporeal life support for near fatal asthma. *Isr Med Assoc J* 2003;5:600–2.
- [9] Del Sorbo L, Pisani L, Filippini C, Fanelli V, Fasano L, Terragni P, et al. Extracorporeal CO₂ removal in hypercapnic patients at risk of noninvasive ventilation failure: a matched cohort study with historical control. *Crit Care Med* 2015;43:120–7.
- [10] Cho WH, Lee K, Huh JW, Lim CM, Koh Y, Hong SB. Physiologic effect and safety of the pumpless extracorporeal interventional lung assist system in patients with acute respiratory failure—a pilot study. *Artif Organs* 2012;36:434–8.
- [11] Lobaz S, Marey M. Rescue of acute refractory hypercapnia and acidosis secondary to life-threatening asthma with extracorporeal carbon dioxide removal (ECCO2R). *J Intensive Care Soc* 2011;12:140–2.
- [12] Elliot SC, Paramasivam K, Oram J, Bodenham AR, Howell SJ, Mallick A. Pumpless extracorporeal carbon dioxide removal for life-threatening asthma. *Crit Care Med* 2007;35:945–8.