

Venovenous extracorporeal membrane oxygenation to treat hypercapnia in a morbidly obese patient

Lederer Heidi^a, Stalder Magnus^{ab}, Tisljar Kai^a, Lanzi Fabio^a, Landmann Emmanuelle^{ab}, Mosimann Tamina^a, Zeeh Franziska^{ab}, Zürcher Stephan^a, Mosimann Vincent^{ab}, Spiegel Rainer^{ab}, Sutter Raoul^a, Hunziker Patrick^a

^a Medical Intensive Care Units, University Hospital Basel, University of Basel, Switzerland

^b Division of Internal Medicine, University Hospital Basel, University of Basel, Switzerland

Summary

Morbid obesity plays an increasingly important role in healthcare. Patients who are severely obese often suffer from a range of medical problems. One problem is obesity-related hypoventilation syndrome with its resulting hypercapnia. We report a case of a 33-year-old female patient who was in an extraordinarily bad medical state, with severe hypercapnia (pCO₂ 15.1 kPa), sepsis, acute anuric kidney failure and resulting acidosis (pH 6.96). Her body mass index was 84 kg/m². Her chances of survival were considered very low after failed attempts at noninvasive ventilation. Based on prior research, we refrained from intubation and chose venovenous extracorporeal membrane oxygenation to treat the hypercapnia. In the entire medical literature, we are not aware of a similarly extraordinary case of obesity-related hypoventilation syndrome that could finally be treated successfully. The idea behind this case report is to consider venovenous extracorporeal membrane oxygenation as an alternative to intubation in this patient collective.

Keywords: *venovenous extracorporeal membrane oxygenation, noninvasive ventilation, sepsis, hypercapnia, obesity hypoventilation syndrome, anuric kidney failure, intensive care unit*

Introduction

For patients with worsening hypercapnia, there are various ways to remove CO₂. One is noninvasive ventilation. There are circumstances, however, where noninvasive ventilation fails. In special populations, such as morbidly obese patients, the solution to failed noninvasive ventilation is not necessarily intubation and subsequent mechanical ventilation, as this puts the patient at risk of ventilation-induced lung injury or pneumothorax. Consequently, this case involves venovenous extracorporeal membrane oxygenation (ECMO) as a means of hypercapnia reduction. It is intended to be an alternative to intubation and mechanical ventilation. Venovenous ECMO as an alternative to intubation, as described in several studies and case reports,

has demonstrated its potential in similar situations before [1–6]. Although venovenous ECMO is known for potential complications, this case demonstrates that the benefits may outweigh the treatment-associated risks in particular populations.

Background

A recent systematic review and meta-analysis came to the conclusion that medical complications of venovenous ECMO frequently occur, but their effect on mortality is limited [1], hence justifying its application in acute respiratory distress syndrome (ARDS). A retrospective study on obese and extremely obese patients with respiratory failure concluded that neither mortality, nor the number of complications was associated with body mass index (BMI) [2].

A study involving more than one hundred consecutive patients with ARDS receiving venovenous ECMO drew a similar conclusion [3]. They found that obesity in terms of BMI was not associated with increased mortality. In contrast, morbidly obese patients had the lowest mortality rates in their analysis. The finding that higher BMI is not related to higher mortality was also revealed in a single-centre review of 55 patients with ARDS [5]. In this study, the group of most obese patients (six patients with an average BMI of 57.3 kg/m²) had a 100 percent survival rate [5].

A recent case report presented a patient with a BMI of 60.2 kg/m² who suffered from obesity hypoventilation syndrome and fluid retention [4]. Because of the high mortality rates for mechanical ventilation in this patient population, the authors applied venovenous ECMO as an alternative to reducing CO₂ by intubation and subsequent mechanical ventilation. The respiratory support applied was through venovenous ECMO and eventually resulted in successful CO₂ elimination. In the meantime, weight loss was initiated following the administration of diuretics [4]. In addition, two cases of successful recovery were reported for morbidly obese patients (BMI 47 kg/m² and 93 kg/m²) with ARDS due to aspiration [6].

Author contributions

Shared first authors:

Heidi Lederer, Magnus Stalder, Kai Tisljar (these authors contributed equally to the manuscript).

Correspondence:

Rainer Spiegel, Division of Internal Medicine, University Hospital Basel, Petersgraben 4, CH-4031 Basel, [rainer_spiegelh\[at\]hotmail.com](mailto:rainer_spiegelh[at]hotmail.com)

Although these examples exist, the evidence regarding venovenous ECMO as a means of CO₂ removal in this population of patients is limited. The present case also involved obesity hypoventilation syndrome and hypercapnia. The case was further aggravated by multi-organ failure as a result of sepsis with altered mental state (obtundation) and acute anuric kidney failure.

Case report

A 33-year-old female patient with morbid obesity (BMI 84 kg/m²) was transferred to our intensive care unit from another intensive care unit. She had been admitted to the first intensive care unit because of sepsis due to bullous erysipelas of the lower left extremity (fig. 1). In the course of treatment, she developed acute anuric kidney failure and was dependent on continuous venovenous haemodiafiltration. The reasons for referral to our intensive care unit were failed noninvasive ventilation attempts and continuous hypercapnia. The patient arrived at our intensive care unit in an obtunded state of consciousness with a pH of 6.96, pCO₂ 15.1 kPa, oxyhaemoglobin 94.6%, base excess -6.5, HCO₃⁻ 25.6 mmol/l. Due to the expected complications of mechanically ventilating the patient, the decision to institute venovenous ECMO was made (fig. 2). Venovenous ECMO helped to successfully remove CO₂. Subsequently, the patient could be weaned from the ECMO, which was disconnected after 8 days. No bacteria were isolated from blood cultures, but a biopsy of the bullous erysipelas revealed *Serratia marcescens*, which responded well to treatment with meropenem. The kidney function improved within 5 days of continuous venovenous haemodiafiltration. The patient was successfully transferred to a nearby rehabilitation centre. She gave her informed consent to discussion of her case in the scientific literature.

What is special about this case is that we are not aware of a more critically ill patient who survived. Our patient had a pH of 6.96, sepsis and multi-organ failure including acute anuric kidney failure and altered mental state (obtundation). These factors contribute to a high mortality. In addition, the BMI of our patient was one of the highest reported in the literature of patients treated with ECMO [1–6]. Hence, percutaneous cannulation was particularly challenging, but possible. It confirms previous publications that have reported that, once the respiratory problem is solved through venovenous ECMO (hence imminent

death was avoided), the other organs will have a chance to recover.

Discussion

In special circumstances, the benefits of venovenous ECMO presumably outweigh the treatment-associated risks and complications. At first sight, one might be tempted to intubate and mechanically ventilate the patient for the purpose of CO₂ elimination, especially if noninvasive ventilation fails. In morbid obesity, however, mortality rates for intubated patients are high. In addition, we would have faced the risk of ventilation-induced lung injury, pneumothorax or other barotrauma when applying pressures high enough to inflate the lungs sufficiently, particularly in our patient with a BMI of 84 kg/m². The relatively fast recovery of our patient suggests venovenous ECMO as a means of CO₂ removal should be considered as an alternative to intubation in this patient population. There is limited evidence in the literature, but recent findings suggest that obesity is not associated with higher mortality when applying venovenous ECMO [2, 3]. A few words of warning need to be issued, though. When installing venovenous ECMO in morbidly obese patients, one should pay a great deal of attention to percutaneous cannulation, which can be challenging as a result of hard skin covering the adipose tissue and a long path to central venous access. Consequently, it should be installed by physicians who are sufficiently experienced in venovenous ECMO. As suggested elsewhere [4], the neck and femoral regions can be prepared for cannulation by applying adhesive tape, which temporarily removes curvatures and wrinkles caused by the adipose tissue underneath the skin [4].

Like mechanical ventilation, ECMO is not without risks. Although mortality was not increased relative to nonobese patients [2, 3, 5], mortality due to complications occurs [1]. Complications are mostly related, but not restricted, to bleeding (including cannula bleeding, intracranial haemorrhage). Other complications include cannula infections [1], oxygenator clotting [2], thrombosis [1, 5], pneumothorax [1] and heparin-induced thrombocytopenia [5]. Although the avoidance of mechanical ventilation reduces the risk of barotrauma and consequent pneumothorax, cannulation to install venovenous ECMO also bears the risk of pneumoth-

Figure 1: The bullous erysipelas



Figure 2: Applying venovenous extracorporeal membrane oxygenation for CO₂ removal as an alternative to mechanical ventilation. The patient gave her informed consent to this publication including anonymous pictures of herself.



orax [1]. Although omission of mechanical ventilation excludes the risk of ventilation-associated pneumonia, aspiration due to somnolence or cannula infections are possible in venovenous ECMO. As a result, it is necessary to carefully weigh the risks and benefits before deciding in favour of venovenous ECMO in morbid obesity.

Potential competing interests

Raoul Sutter received research grants from the Swiss National Foundation (No 320030_169379), the Research Fund of the University Basel, the Scientific Society Basel, and the Gottfried Julia Bangerter-Rhyner Foundation. He received personal grants from UCB-pharma and holds stocks from Novartis and Roche.

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