Double lumen bi-cava cannula for veno-venous extracorporeal membrane oxygenation as bridge to lung transplantation in non-intubated patient

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Abstract

Extracorporeal membrane oxygenation (ECMO) is used for refractory respiratory failure. Normally, ECMO is implanted in intubated patients as a last resort. We report the case of a non-intubated patient who benefited from veno-venous (VV) ECMO. A 35-year old cystic fibrosis man presented a severe respiratory decompensation with refractory hypercapnia. We opted for an ECMO instead of mechanical ventilation (MV). We implanted a double lumen bi-cava cannula (DLC) (Avalon Elite™) in the right jugular vein. Before ECMO implantation, the patient presented refractory respiratory failure (pH = 7.1, PaO2 = 83 mmHg, PaCO2 = 103 mmHg). We proposed that the patient be placed on the high emergency lung transplantation waiting list after failure to wean him from ECMO. This registration was effective 10 days after ECMO implantation. The patient was grafted the next day. Under ECMO, mean PaO2, PaCO2 and TCA were 80.6 ± 14.2, 53.8 ± 6.4 mmHg and 56.2 ± 9.7 s, respectively. The patient could eat, drink, talk and practice chest physiotherapy. The evolution was uneventful under ECMO. Weaning from ECMO was done in the operating theatre after transplantation. VV ECMO with DLC in a non-intubated patient is safe and feasible in non-intubated patients. It avoids potential complications of MV, and allows respiratory assistance as bridge to transplantation.

Keywords: Extracorporeal membrane oxygenation • Veno-venous extracorporeal membrane oxygenation • Non-intubated patient • Transplantation • Lung transplantation • Bridge to transplantation • Cystic fibrosis

INTRODUCTION

Extracorporeal membrane oxygenation (ECMO) is a cardiopulmonary bypass technique for respiratory or cardio-respiratory assistance. Veno-venous (VV) technique is preferentially and increasingly used in respiratory pathology. ECMO is performed in case of respiratory failure with refractory hypoxaemia and/or hypercapnia [1]. Normally, ECMO is implanted in intubated and sedated patients, previously treated by mechanical ventilation (MV) and optimal conventional medical therapy. We report the successful case of a non-intubated cystic fibrosis patient, awake and spontaneously breathing, who benefited from VV ECMO with double lumen bi-cava cannula (DLC) (Avalon Elite™) as bridge to lung transplantation (LTx). There is no similar data of VV ECMO with DLC in a non-intubated patient in the literature.

CASE REPORT

A 35-year old man with cystic fibrosis presented a severe respiratory decompensation with refractory hypercapnia and respiratory acidosis (pH = 7.10, PaO2 = 83 mmHg, PaCO2 = 103 mmHg) despite optimal medical therapy and non-invasive ventilation. The patient was a farmer without major restrictions in his occupation. He had never met the criteria for LTx; hence no pre-transplant assessment was made. Confronted with his severe and refractory respiratory failure, we opted for a VV ECMO. We implanted a 27F DLC with the Seldinger method in the right internal jugular vein under local anaesthesia and non-invasive ventilation. DLC was then connected to the extracorporeal circuit. A 1 mg/kg intravenous unfractionated heparin bolus was done during implantation. The DLC correct position was checked with trans-chest Doppler ultrasound. The main parameters assessed during the ECMO procedure were: arterial pH, arterial oxygen pressure (PaO2), arterial carbon dioxide pressure (PaCO2), TCA and blood products transfused. Specific ECMO parameters (FiO2, blood flow and gas flow), as well as the occurrence of thromboembolic and haemorrhagic complications, were also recorded. Under ECMO, mean pH, PaO2 and PaCO2 were 7.33 ± 0.04 [7.23–7.38], 80.6 ± 14.2 mmHg [60–105] and 53.8 ± 6.4 mmHg [43–64], respectively. The mean TCA was 56.2 ± 9.7 s [44–80]. The daily biological evolution is represented in Fig. 1. As for blood products, seven pellets of red blood cells (pRBC), three pellets of fresh frozen plasma and one pellet of a mixture of concentrate platelet were transfused. The mean ECMO FiO2, gas flow and blood flow were 0.75 ± 0.2 [0.6–1], 13.2 ± 2.52 [10–15] and 2.7 ± 0.71 [2.1–3.8], respectively. For the entire period of ECMO therapy, the patient was able to eat, drink, talk and practice physiotherapy (Fig. 2). Our attempt to wean the patient from
ECMO on the eighth and ninth day of respiratory support was unsuccessful, and furthermore, the concomitant worsening of arterial blood gases prompted us to register the patient as high emergency on the LTx waiting list. The registration was effective 10 days after DLC implantation. The patient received a bilateral LTx 11 days after DLC implantation. The procedure was uneventful. Weaning from ECMO was done at the end of the LTx in the operating theatre since the patient’s haematosis parameters had favourably evolved (arterial blood gases with ECMO flow = 1.5 l/min, ECMO FiO₂ = 21%, ECMO gas flow = 1 l/min and MV with FiO₂ = 50%: pH = 7.28, PaO₂ = 87 mmHg, PaCO₂ = 46 mmHg).

**DISCUSSION**

This case, to the best of our knowledge, is the first non-intubated VV ECMO with DLC reported, as a bridge to LTx. Why is it beneficial to use VV ECMO with DLC in this particular situation and why before MV?

The decision to use an ECMO prior to the use of MV was mainly guided by the poor prognoses and outcomes of patients with cystic fibrosis treated by MV [2]. This strategy also allowed us to avoid the potential drawbacks of orotracheal intubation and long-term MV, particularly septic complications, in a cystic fibrosis patient. VV ECMO in conscious patients has been described in a few reports. Broomé et al. [3] presented the case of a man for whom femoro-femoral ECMO was initiated prior to intubation and general anaesthesia. Then, another cannula was inserted in the right jugular vein under general anaesthesia and a tracheostomy was performed. Nossotti et al. [4, 5] recently reported two cases of VV ECMO in non-intubated patients without precisely describing the technical aspect of their assistances.

In our patient, the major problem was the refractory hypercapnia. We were faced with an isolated respiratory failure and VV ECMO was, from our point of view, the best solution. Indeed, besides providing total gas exchange, the VV ECMO with the DLC allowed the patient to be perfectly ambulatory with freedom of his lower limbs to exercise (without fear of an ischaemic or haemorrhagic problem related to arterial cannulation). This patient was able to eat and drink, speak, practice active and passive physiotherapy, and receive psychological support. However, another possible option would have been the use of the pumpless intervention lung assist device, Novalung [6, 7]. Bartosik et al. [6] recently reported its successful use as a bridging strategy in non-intubated patients. As our patient experienced no circulatory failure, we did not need any haemodynamic support such as veno-arterial (VA) ECMO. Olsson et al. [8] reported the use of VA ECMO in five conscious and spontaneously breathing patients. All five patients presented cardiopulmonary failure due to pulmonary hypertension.

Initially, we thought that we could wean the patient from ECMO and register him on the LTx waiting list at the resolution of the acute episode. Nevertheless, we preventively started the pre-LTx assessment from the first day of ECMO. Finally, after two failures of ECMO weaning, we decided to register him on the high emergency LTx waiting list. The patient remained non-intubated until his arrival in the operating theatre for the LTx and the evolution under ECMO was uneventful. As for blood products, our transfusion requirements were similar to those found in the literature for a 27F DLC. Indeed, Javidfar et al. [9] reported requiring 0.66 pRBC per day (0.63 in our case).

**CONCLUSION**

VV ECMO with DLC is feasible in non-intubated patients with isolated and refractory respiratory failure. It avoids the potential drawbacks of MV. VV ECMO in non-intubated patients allows a reliable respiratory assistance. It is our opinion that this strategy introduces new therapeutic perspectives. We hope to expand, not only this effective strategy as bridge to LTx, but also broaden the indicators for treating respiratory failure with a bridge to lung recovery. With the evolution of technology, our patients could even be mobile, as is the case with circulatory support.

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REFERENCES