

## CASE REPORTS

# Management of a bi-caval dual lumen cannula clot obstruction after TEE guided diagnosis: a case report



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### KEYWORDS

Acute respiratory distress syndrome;  
Catheters, indwelling;  
Echocardiography, transesophageal;  
Extracorporeal membrane oxygenation;  
Troubleshooting

### Abstract

**Background:** Venovenous extracorporeal membrane oxygenation is an established therapy for patients with refractory acute respiratory distress syndrome (ARDS). One complication related to the use of venovenous extracorporeal membrane oxygenation is thrombosis despite proper anticoagulation. We report the diagnosis and management of a clot-obstruction in a single site cannula placed through the internal jugular vein, guided by transesophageal echocardiography. **Case report:** A 39 year-old male developed acute respiratory distress syndrome and hemodynamic instability after an episode of pulmonary aspiration in the ICU. Eight hours after placement of a single site venovenous extracorporeal membrane oxygenation, suddenly the perfusionist noticed a reduction in flow. TEE showed a thrombus-like mass obstructing the inflow port in SVC and inflow at IVC was intact. After unsuccessful attempts to reposition the cannula, the team decided to insert additional femoral inflow cannula through the IVC. The single site catheter was then pulled out until its tip was positioned in the right atrium and all three ports of the catheter were switched to the infusion ports. After this, flows and oxygenation improved significantly. Unfortunately, despite all of the efforts, the patient died 2 days later.

**Discussion:** The diagnosis of venovenous extracorporeal membrane oxygenation cannula obstruction is based on reduced inflow rates, hemodynamic instability and poor oxygenation of blood. TEE allows evaluation of the flows inside the cannula and in this case, an obstruction was found. The management presented points to the fact that in a situation of catheter obstruction caused by a clot, there is a feasible alternative to assure minimal interruption of the hemodynamic support offered by the venovenous extracorporeal membrane oxygenation. © 2020 Sociedade Brasileira de Anestesiologia. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

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**PALAVRAS-CHAVE**

Síndrome do desconforto respiratório agudo; Catéteres, canulação; Ecocardiografia, transesofageana; Oxigenação por membrana extracorpórea; Resolução de problemas

## Conduta em obstrução por coágulo em cânula de duplo lúmen bicaval após diagnóstico guiado por ETE: relato de caso

**Resumo**

*Justificativa:* A oxigenação por membrana extracorpórea veno-venosa é terapia estabelecida para pacientes com a síndrome do desconforto respiratório agudo. Uma complicação relacionada ao uso da oxigenação por membrana extracorpórea veno-venosa é trombose apesar de anti-coagulação adequada. Relatamos o diagnóstico e conduta em obstrução por coágulo em cânula de acesso único inserida pela veia jugular interna, guiada por ecocardiografia transesofageana.

*Relato de caso:* Paciente do sexo masculino de 39 anos desenvolveu síndrome do desconforto respiratório agudo e instabilidade hemodinâmica após episódio de aspiração pulmonar na UTI. Oito horas após a instalação de oxigenação por membrana extracorpórea veno-venosa de acesso único, o perfusionista notou repentina redução no fluxo. A ETE revelou massa semelhante a um trombo obstruindo o portal de fluxo de entrada na VCS e o fluxo de saída na VCI estava intacto. Após tentativas sem sucesso para reposicionar a cânula, a equipe decidiu inserir cânula de entrada de fluxo adicional pela VCI. O catéter de acesso único foi então puxado até que sua ponta se posicionasse no átrio direito e todos os três portais do catéter fossem transferidos para os portais de infusão. A seguir, os fluxos e oxigenação melhoraram significativamente. Infelizmente, apesar dos esforços, o paciente foi a óbito 2 dias depois.

*Discussão:* O diagnóstico de obstrução de cânula da oxigenação por membrana extracorpórea veno-venosa se baseia em velocidades reduzidas de entrada de fluxo, instabilidade hemodinâmica e oxigenação pobre do sangue. A ETE permite a avaliação dos fluxos dentro da cânula, e nesse caso foi encontrada obstrução. A técnica apresentada aponta para o fato de que em situação de obstrução de catéter causada por coágulo, existe alternativa factível para garantir interrupção mínima do suporte hemodinâmico oferecido pela oxigenação por membrana extracorpórea veno-venosa.

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**Introduction**

Veno-Venous Extracorporeal Membrane Oxygenation (VV-ECMO) is an established therapy for patients with refractory lung disease, such as Acute Respiratory Distress Syndrome (ARDS).<sup>1</sup>

Cannulation for VV-ECMO involves a 2-site or a single-site approach. In the 2-site approach, blood is withdrawn from a central vein through a drainage cannula, and the oxygenated blood is returned through a second cannula. This approach may result in recirculation of oxygenated blood into the circuit in a closed loop without contributing to systemic oxygenation.<sup>2</sup> Recently developed Avalon Elite™ is placed through the internal jugular vein with the drainage lumens open to Superior Vena Cava (SVC) and Inferior Vena Cava (IVC) while the infusion lumen opens to the right atrium. Blood is withdrawn through the drainage ports, oxygenated through the artificial lungs and then the blood is returned through the infusion lumen at the level of the right atrium with the flow directed towards the tricuspid valve. Appropriately positioned cannula reduces the chance of the recirculation.<sup>2</sup>

One known complication related to the use of ECMO is thrombosis, despite proper anticoagulation.<sup>3</sup>

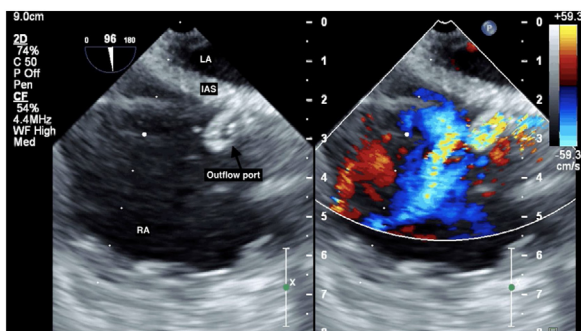
We report a case of an obstruction in one of the lumens of Avalon Elite™, which led to low flow and critical acidosis. Under TEE guidance, a diagnosis of obstruction in one of the

drainage ports was made and appropriate action was taken to successfully fix the problem.

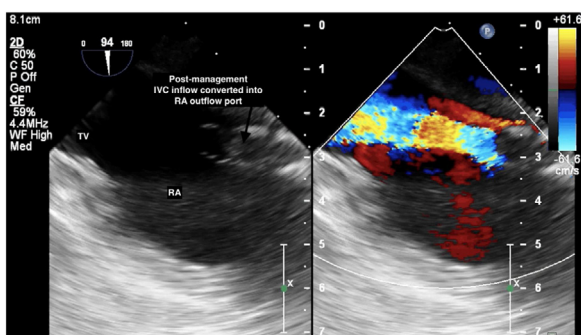
**Case report**

Consent to use this case for learning purposes was signed by the family. A 39 year-old male who was previously healthy presented with injuries related to a motor vehicle accident to the Emergency Department of our Hospital. On arrival, he was found to have massive internal bleeding that resulted in hypotension and tachycardia. As a result, he required massive blood transfusion and a resuscitative left-sided thoracotomy. Return of Spontaneous Circulation (ROSC) was achieved after cross clamp of the aorta and the placement of chest tubes. Subsequently, he underwent a laparotomy with a terminal ileal resection and anterior resection of the sigmoid/rectum. Additional important findings included bilateral pulmonary contusions.

During his recuperation in ICU, he had an episode of aspiration due to a ruptured cuff in his endotracheal tube. Following this episode, his respiration deteriorated significantly, and his requirements for vasoactive drugs increased due to critical pneumonia. As a result, he developed ARDS with a markedly low PaO<sub>2</sub>/FiO<sub>2</sub> ratio of 59 and hemodynamic instability. A decision was made for a bedside placement of a single site VV-ECMO with an Avalon Elite™ catheter under TEE guidance. Following this, his oxygenation as well



**Figure 1** Mid-Esophageal Bicaval view focusing on the outflow port of the Avalon cannula before the management described, showing a non-dense outflow jet with low velocities, compatible with low flow in the outflow port. (RA, Right Atrium; LA, Left Atrium; IAS, Interatrial septum).



**Figure 2** Mid-Esophageal Modified Bicaval view showing the previous IVC inflow port, converted into the outflow port after the management described, with a dense and high-velocity organized jet directed towards the Tricuspid Valve. (RA, Right Atrium; TV, Tricuspid Valve).

as hemodynamics improved significantly. Arterial blood gas showed improvement in  $pO_2$  from 38 to 50 mmHg and  $pCO_2$  from 80 down to 45 mmHg.

Eight hours after VV-ECMO was initiated, suddenly the perfusionist noticed a reduction in flow. The cardiac anesthesia team was called to investigate the cause of low flow and guide the reposition of the catheter. TEE showed a thrombus-like mass obstructing flow in the drainage port in SVC (velocity > 150 cm/sec), and inflow at IVC was intact (velocity = 50 cm/sec). Outflow was not directed towards tricuspid valve (Fig. 1).

After multiple attempts to reposition the cannula failed, the team decided to insert additional femoral inflow cannula through the IVC all the way to the RA. Following this, the Avalon Elite™ cannula was pulled until its tip was positioned in the right atrium and the three ports of the catheter were switched to the infusion ports (Fig. 2). After this, flows and oxygenation improved significantly.

Unfortunately, despite all the efforts, the patient kept deteriorating and died 2 days later.

## Discussion

The diagnosis of VV-ECMO cannula obstruction is based on reduced inflow rates, hemodynamic instability and poor

**Table 1** Protocol to adjust heparin infusion in patients on ECMO.

PTT (sec)	Hold	Rate Change	Recheck PTT
Less than 40	0	+2 units/kg/h	6 hours
40–49	0	+1 unit/kg/h	6 hours
50–64	0	No change	Next AM
65–74	0	–1 unit/kg/h	6 hours
Greater than 75	60 min	–2 units/kg/h	6 hours after restart

oxygenation of the blood. The most common encountered causes include mispositioning or displacement of the cannulas and recirculation. In the current case, an obstruction in one of the drainage ports was found on TEE.

The key role of TEE for troubleshooting has been published so far. The use of TEE allows an accurate evaluation of the flows inside the cannula, and these measurements make it possible to pinpoint the cause of low flow in some cases.<sup>4</sup>

Thrombosis is a major complication that leads to low flow in ECMO, and TEE is considered to be one of the most important tools for proper assessment and diagnosis of this complication.<sup>5</sup> Thorough examination using TEE can lead to accurate diagnosis of underlying problems.

Anticoagulation is a fundamental part of patients' care using a ECMO device.<sup>3</sup> In our institution, a heparin infusion of 6 U/kg/h is usually stated after ECMO installation, and anticoagulation levels are monitored with PTT as presented in Table 1. However, due to massive hemorrhage and transfusion, an agreement among the physicians involved in patient's care was made and anticoagulation didn't start right after ECMO installation.

This case report supports the indispensable role of echocardiography in achieving and confirming adequate VV-ECMO cannula positions under TEE guidance. Avalon Elite™ allows better patient mobilization with one single cannula through the internal jugular vein. However, instructions for trouble shooting have not been described since it became commercially available, only recently. We hope this case report helps clinicians to better manage patients receiving treatments with Avalon Elite™.

The management of the complication presented in this report points to the fact that in a situation of catheter obstruction caused by a clot there is a feasible alternative to assure minimal interruption of the hemodynamic support offered by the VV-ECMO. The clot will be managed with anticoagulants and the port that contains the clot will obviously not be used as an outflow port. Possibly the risk of thromboembolic events is increased, but the severity of the clinical presentation and the necessity of mechanical support overcomes this risk.

## Summary

In summary, TEE is an important tool to evaluate the causes of low flows during a VV-ECMO. Moreover, it facilitates troubleshooting through demonstrating if the flows on the tips of the catheters are adequate and well directed toward regions

of interest. The approach with single site VV-ECMO catheters is relatively new and if a thrombus is causing obstruction to the system, it is possible to convert it into a conventional double site system through an insertion of a second cannula.

We experienced a case of port obstruction in Avalon Elite™ eight hours after VV-ECMO started. Under TEE guidance, we were able to diagnose the cause in a timely fashion and proactively deal with the problem. TEE is an indispensable part of patient care in ICU. When utilized properly, it provides significant clinical benefits.

### Conflicts of interest

The authors declare no conflicts of interest.

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