

# Ambulatory femoral venovenous extracorporeal membrane oxygenation with a dual-lumen cannula



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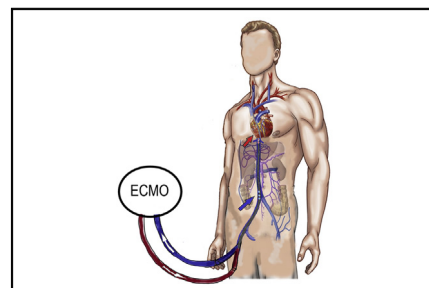
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A 27-year-old woman with end-stage lung disease secondary to mixed connective tissue disorder and history of prolonged venovenous (VV) extracorporeal membrane oxygenation (ECMO) in 2015 presented to our institution. Notably, this was complicated by right internal jugular vein and superior vena cava thrombosis. Over the past 6 months, she had progressive decline of her pulmonary function with increased oxygen requirements and was listed for bilateral lung transplant. The operation was performed successfully; however, significant lung edema was noticed requiring partial chest closure with a negative pressure dressing. Postoperatively, she became hypotensive with transthoracic echocardiogram showing dilated right ventricle. Subsequently, she developed ventricular fibrillation likely secondary to acute right ventricle failure. Femoral venoarterial ECMO was placed in an emergency operation (15Fr arterial and 21Fr multistage venous catheter) and return of systemic circulation was obtained. Postprocedure transthoracic echocardiogram showed normal biventricular function; however, the patient developed critical limb ischemia, so the arterial cannula was removed and the femoral artery repaired. At this point, we planned to switch to VV-EMCO; however, the occlusion of the superior vena cava precluded the insertion of any cannula. With just 1 venous access available, exchange of the right femoral venous cannula to a 32-Fr Protek Duo (TandemLife, Pittsburgh, Pa) cannula was performed. Intraoperative transthoracic echocardiogram showed the inflow cannula jet in the suprahepatic inferior vena cava (IVC) with mild tricuspid regurgitation. Postoperative course was complicated by hypoxic/anoxic brain injury, and acute kidney injury requiring renal replacement therapy. Physical



Red arrow indicates distal ports in the cavo-atrial junction. Blue arrow indicates proximal ports in distal IVC.

### CENTRAL MESSAGE

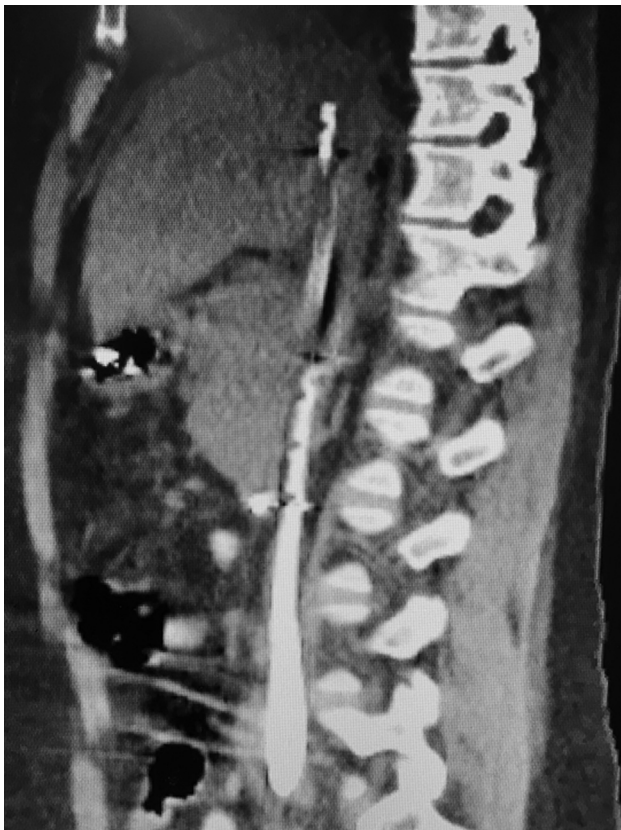
Femoral VV-ECMO with a single dual-lumen cannula is a feasible option for selected patients requiring long-term support, allowing early physical conditioning and more effective rehabilitation.

See Commentaries on pages 202 and 204.

therapy evaluation was initiated on postoperative day (POD) 11. The patient was able to complete hip flexion from 0° to 90° with stable ECMO flows. Edge of bed mobility was attempted on POD 13. Patient started ambulating on POD 32. She ambulated 70 feet with maximal assistance and progressed to 444 feet with the use of an EVA Walker (Follo Futura AS, Norway) on POD 39. After 24 hours of successful capping of VV-ECMO, the cannula was removed on POD 49. Patient was discharged home 3 months after transplant. At 4-month follow-up, the patient was doing well on room air with minimal use of bi-level positive airway pressure and normal renal function. Informed consent was obtained at this visit.

### DISCUSSION

Lung transplant is the treatment of choice for end-stage pulmonary disease in selected patients.<sup>1</sup> Early postoperative ambulation and physical therapy are essential for prompt rehabilitation; however, some patients may require ECMO



**FIGURE 1.** First set of ports of the proximal inflow positioned in the inferior vena cava.



**FIGURE 2.** Second set of ports of the distal outflow in the inferior vena cava/right atrium junction.

for postoperative rescue.<sup>2</sup> Novel strategies such as awake ECMO and dual-lumen cannulas may help improve patient mobility, rehabilitation, and outcomes.<sup>3</sup> ECMO support and a lung protective ventilation approach has been shown to be beneficial for the transplanted lung.<sup>4</sup> The different ECMO configurations and strategies are designed to support ambulatory patients with distinct clinical needs (eg, hypoxia or hypercapnia). The rationale for ambulatory ECMO is based on the concept of increased chance of recovery and subsequent bridge to transplant with early ambulation and improved physical activity, avoiding the detrimental consequences and profound deconditioning associated with prolonged intubation, sedation, paralysis, and the related complications (eg, pneumonia or barotrauma).<sup>5</sup>

In this case, the Protek Duo cannula was used because the only patent vessel for adequate access was the right femoral vein. The possibility of using just 1 vessel for ECMO cannulation is the main advantage of this strategy. With this approach and the use of ultrasound-guided puncture, the femoral vein is easily accessible, the procedure is faster, and has less risk of complications compared with a cervical technique. Moreover, there is less risk of arterial injury and subsequent arterial complications and the explant of the cannula is percutaneous. In

this patient, the proximal inflow was positioned in the IVC (Figure 1), and the distal outflow lumen was positioned in the IVC/right atrium junction (Figure 2). The length of the cannula was adequate without evidence of recirculation and ECMO support was optimal. Among the cornerstones for the success of this approach is patient height. We have used this strategy before in patients of average height, but in a different clinical scenario (ie, VV-ECMO for acute respiratory failure not related to lung transplant), with effective clearance of carbon dioxide, but more recirculation, which prevented optimal oxygenation. This phenomenon is the main limiting factor of this strategy; however, this aspect could be less important if the goal is carbon dioxide removal. To our knowledge, this is the first case report of successful (off-label) use of a femoral dual-lumen cannula for long-term ambulatory VV-ECMO. We believe this is a useful and promising strategy for patients with limited vascular access and without brachiocephalic venous access who require VV-ECMO.

## References

1. Chambers DC, Yusen RD, Cherikh WS, Hayes D Jr, Hsich E, Khush KK, et al. The Registry of the International Society for Heart and Lung Transplantation: thirty-sixth adult lung and heart lung transplantation report-2019; focus theme: donor and recipient size match. *J Heart Lung Transplant.* 2019;38:1042-55.

2. Van Raemdonck D, Hartwig MG, Hertz MI, Davis RD, Cypel M, Hayes D Jr, et al. Report of the ISHLT Working Group on primary lung graft dysfunction part IV: prevention and treatment: a 2016 Consensus Group statement of the International Society for Heart and Lung Transplantation. *J Heart Lung Transplant*. 2017;36:1121-36.
3. Lehr CJ, Zaas DW, Cheifetz IM, Turner DA. Ambulatory extracorporeal membrane oxygenation as a bridge to lung transplantation: walking while waiting. *Chest*. 2015;147:1213-8.
4. Gomez-Abraham JA, Brann S, Aggarwal V, O'Neill B, Alvarez R, Hamad E, et al. Use of Protek Duo cannula (RVAD) for percutaneous support in various clinical settings: a safe and effective option. *J Heart Lung Transplant*. 2018;37(suppl):S102.
5. Hoopes CW. Ambulatory extracorporeal membrane oxygenation. Available at: [https://www.optechtcs.com/article/S1522-2942\(14\)00092-0/pdf](https://www.optechtcs.com/article/S1522-2942(14)00092-0/pdf). Accessed June 26, 2021.

**Key Words:** ambulatory, VV-ECMO, dual-lumen cannula