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Case Report

Uneventful Management of an Adult Venovenous Extracorporeal Membrane Oxygenation with the Reinjection Cannula in a Persistent Left Superior Vena Cava

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PERSISTENT LEFT SUPERIOR VENA CAVA (PLSVC) is the most common anomaly of the major veins and is present in 0.3% to 0.5% of the population.[1] PLSVC is an embryologic remnant that failed to involute. Anatomically, it begins at the junction of the left subclavian and left internal jugular (LIJ) veins and drains into the right atrium via the coronary sinus (CS) in 90% of cases. In 10%, it drains into the left atrial chamber.[1-3] Current literature on the subject emphasizes that the clinician should screen patients to secure the placement of upper body venous catheters as complications can occur.[4]

This condition can be found in adults and is mostly asymptomatic;[5] however, it can be associated with other cardiac abnormalities such as bicuspid aortic valve, coarctation of the aorta, CS ostial atresia, and cor triatrium.[2]

Diagnosis of this abnormality can be made using imaging such as transesophageal (TEE) or transthoracic echocardiography (TTE), contrast-enhanced computed tomography (CT), or magnetic resonance imaging. However, in adults, the diagnosis is often made when a catheter appears misplaced in the LIJ vein on a chest X-ray.[6]

The authors describe a case of uneventful management of a venovenous extracorporeal membrane oxygenation (vvECMO) placement with the reinjection cannula inserted into a PLSVC in an adult.

Case Description

A 27-year-old male was transferred to the authors' tertiary hospital under vvECMO in the context of acute respiratory

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distress syndrome. The patient had no known comorbidities other than severe obesity (BMI = 39.9) and well-controlled asthma.

Five days before admission, the patient consulted his general practitioner for flu-like symptoms. He was put on antibiotics (amoxicillin-clavulanate rapidly shifted to moxifloxacin). A blood sample showed elevated C-reactive protein and white blood cells.

Five days later, still unwell, the patient went to the emergency department, where blood tests and a CT scan revealed right lung pneumonia due to *Haemophilus influenzae.* Blood cultures were negative. On the second day of his hospital stay, he developed a pneumothorax, treated with a chest tube. A new CT scan performed on day 5 showed empyema and a right upper lobe abscess, necessitating two thoracic surgeries and intensive care unit (ICU) admission for mechanical ventilation. The first surgery, on day 5, involved video-assisted thoracoscopic drainage, identifying *Actinomyces odontolyticus.* The second surgery, on day 11, was an open thoracotomy for abscess drainage, pleural decortication, and closing a bronchopleural fistula. The patient received antibiotics (piperacillin/tazobactam, penicillin, vancomycin, ceftriaxone) and systemic corticosteroids.

He then developed acute kidney injury necessitating renal replacement therapy due to hypervolemia. A double-lumen catheter was, therefore, placed in the right internal jugular (RIJ) vein as the central venous line occupied the right subclavian vein.

On day 20, the patient developed respiratory failure. Positive end-expiratory pressure was then titrated to higher levels, and prone positioning was initiated along with intermittent neuromuscular blockade. As the patient continued to deteriorate, the mobile ECMO team was mandated on the evening of day 21 to implement percutaneous vvECMO locally.

Due to the position of the previous catheter, the mobile ECMO team decided to insert the injection cannula (Medtronic, 21 French, Minneapolis) in the LIJ vein while the aspiration cannula (Medtronic, 25 French) was inserted through the right femoral vein. The procedure went without notable complications, but the positioning of the cannulas could not be confirmed by TEE because no one was available locally to perform TEE late in the evening. The flow of the vvECMO was raised to 5 liters per minute and the inlet and outlet pressure remained satisfactory. The procedure started at an FiO_2 of 100%, positive end-expiratory pressure of 12 cm H_2O, and tidal volume of around 450 mL. After the successful placement of vvECMO, FiO_2 could be reduced to 50% and the patient was transferred to the authors' center for further management.

At the authors' tertiary hospital, a routine chest X-ray was performed (Fig 1). It showed the LIJ cannula following a straight pathway onto the left side of the mediastinum. It was, therefore, hypothesized that the patient had a double superior vena cava with a PLSVC into which the reinjection cannula was inserted. To confirm the diagnosis and exclude other cardiac abnormalities, TEE was performed with a microbubble contrast test, injected through the right subclavian catheter, and contrast-enhanced CT (Fig 2). TEE could not visualize the left jugular cannula but showed a dilated CS, raising suspicion of PLSVC (Fig 3 and Supplement S1). The vvECMO did not show any signs of dysfunction; therefore, in agreement with the surgical team, the authors decided to maintain the ECMO circuit as it was.

Fig 1. Chest X-ray at admission to the authors' hospital showing the left pathway of the reinjection cannula. The *white arrow* shows the reinjection cannula.

Fig 2. Computerized tomography of the lungs showing the cannula inside the persistent left superior vena cava that drains into a dilated coronary sinus. The *white arrow* shows the reinjection cannula. The *white circle* shows the dilated coronary sinus that drains into the right atrium just above.

On day 23, a third thoracic surgical intervention was needed to maximize the drainage of the abscess and complete the clearance of the pleural cavity. Blood cultures and pleural fluid cultures showed the growth of *Lactobacillus casei*. Antibiotherapy was adjusted accordingly. The vvECMO was weaned on day 30, and the patient was extubated the day after without complications.

After the removal of vvECMO, another contrast-enhanced CT was performed. It showed the anatomy of the PLSVC

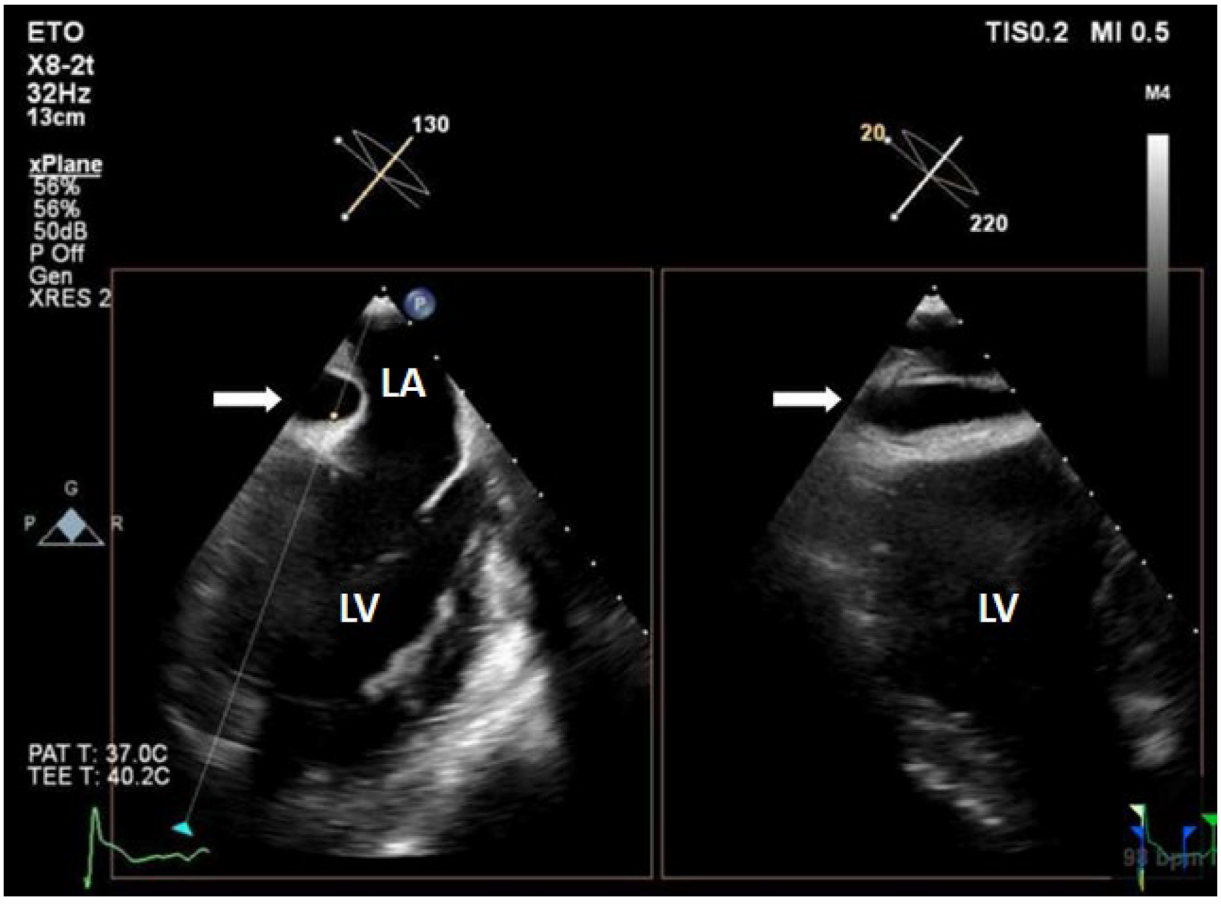

Fig 3. Transesophageal echocardiography: midesophageal 130˚ to 120˚ X-plane views. The *white arrow* shows the dilated coronary sinus, indicating probable persistent left superior vena cava. LA, left atrium; LV, left ventricle.

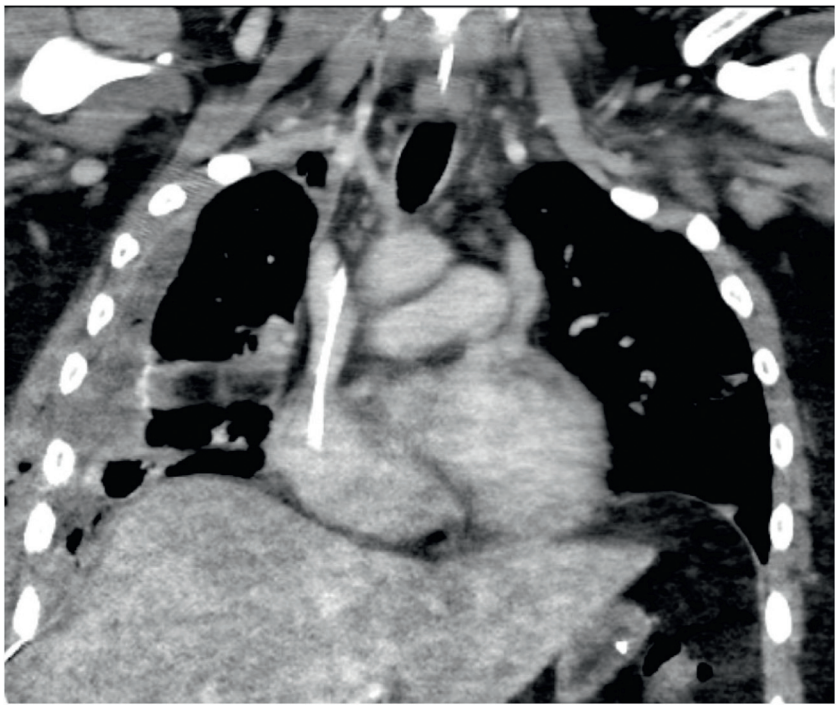

Fig 4. The *white arrow* shows the persistent left superior vena cava after the removal of the extracorporeal membrane oxygenation cannula.

draining into the coronary sinus and an LIJ vein thrombosis at the insertion site of the vvECMO cannula at a height of 6 centimeters (Fig 4), necessitating systemic anticoagulation. A TTE with injection of microbubbles through the left cephalic vein was also performed, demonstrating early filling of the enlarged CS (15 × 25 mm) by the microbubbles (Fig 5 and Supplement S2). The patient was allowed to leave the ICU on day 43 and returned home on day 56.

Discussion

Case reports of cannulation of the PLSVC for vvECMO are rare but have been described in infants.[7,8] However, in the pediatric population, vvECMO cannulation of the PLSVC is usually due to the absence of the right superior vena cava.

To our knowledge, this is the first case report of an uneventful vvECMO cannulation of a PLSVC in an adult patient presenting with double superior vena cava. In the case reported by Rajavardhan et al.,[9] the ECMO cannula was placed in the right superior vena cava, and only the central venous line was placed in the PLSVC. However, their patient experienced obstruction of the superior venous return (superior vena cava syndrome [SVCs]), resulting in the removal of the venous catheter. In the current case, large cannulas in both superior vena cava did not result in SVCs, likely because the patient was morbidly obese, leading to larger vessel diameters. In the case described by Strojek et al.,[10] the patient had a venoarterial ECMO with the drainage cannula inserted into the PLSVC.

Literature about PLSVC catheterization mostly reports vascular complications (eg, dilatator-induced vessel injury[4]) or SVCs.[9,11] In the current case, the vvECMO functioned properly, likely due to two factors: the cannula in the PLSVC was the reinjection cannula, not the inflow cannula, and the patient's large measurement probably explains the adequate width of the PLSVC and CS (15 × 25 mm) tolerating 5 L/min of ECMO flow. However, this cannulation was complicated by a LIJ vein thrombosis necessitating prolonged anticoagulation.

The current literature is mostly based on case reports. When PLSVC is known before cannulation, current practice recommends avoiding cannulation of the upper body and favoring, therefore, vvECMO cannulation of both femoral veins.[12,13,14]

This case shows that clinical practice should balance the risks and benefits of the replacement of an ECMO cannula found in the PLSVC if the circuit is working properly due to the possibly catastrophic complications that can occur.

In the case of nonemergent ECMO implantation, screening for vascular malformation should still be a priority before considering the site of insertion of ECMO cannulas, as large vessel injuries often result in the patient's death.[4,13,15] To avoid such complications, current guidelines in ECMO management advise the use of TTE or TEE to guide to the positioning of the cannulas.[16-18] In nonurgent situations, as in the current case, the standard approach would have been to use the RIJ vein[16] and, therefore, remove the previous catheter in the RIJ vein, especially when a continuous renal replacement therapy catheter is in place, as continuous venovenous hemofiltration can be effectively run on the ECMO circuit[19,20] Bifemoral cannulation is another reasonable alternative but is less preferred as recirculation can occur.[14,21] After cannula insertion, correct positioning can be assessed using TEE or TTE with a microbubble test, contrast-enhanced CT or magnetic resonance and, optionally, venous angiography, as mentioned in this case.

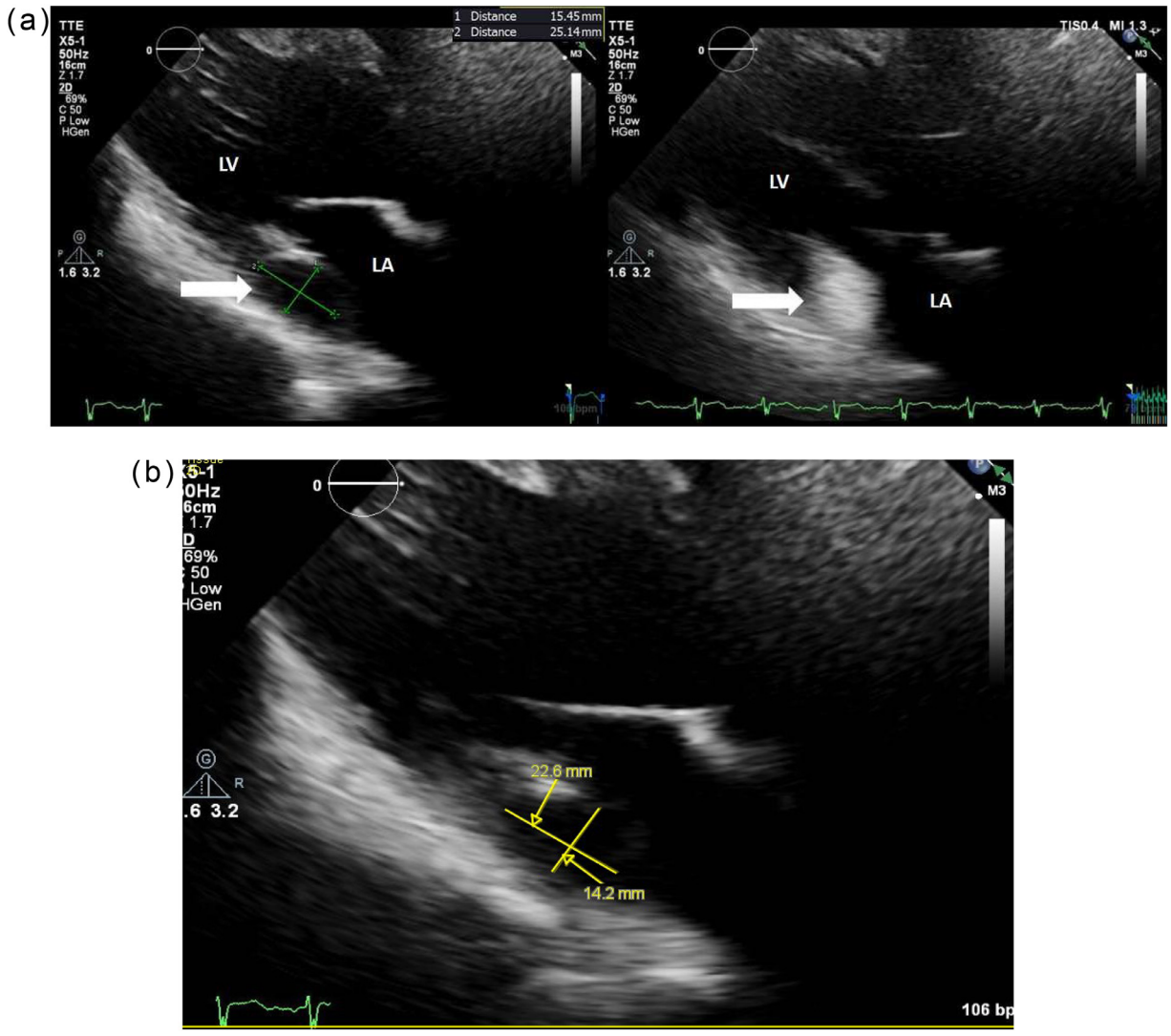

Fig 5. Transthoracic echocardiography: parasternal long-axis view. The *white arrow* shows the dilated coronary sinus before (*left*) and after injection of microbubbles of agitated saline (*right*) through the left cephalic vein. The last figure shows the dimension of the dilated coronary sinus. LA, left atrium; LV, left ventricle.

Echocardiographic Work-up

As illustrated by this case, echocardiography plays a pivotal role in confirming the bedside diagnosis of PLSVC. Typically, an enlarged CS with normal right-sided pressures that is rapidly filled by microbubbles of agitated saline injected through the left forearm should raise high suspicion of PLSVC draining in the CS. This rapid filling by microbubbles occurs earlier than the filling of the right cavities. (Supplement S1). The CS could be visualized in TTE on parasternal long-axis view and apical four- (4C) and two-chamber (2C) views; in TEE, the CS is visualized on midesophageal (ME) 4C and 2C views or on ME modified 4C view. In TEE, the ME bicaval view also allows the visualization of the enlarged CS and, in the case of isolated PLSVC, also shows the absence of the right superior vena cava. This was not the case in the current patient, as he had a double superior vena cava. This double superior vena cava explained why, by injecting the microbubbles of agitated saline through the central venous catheter (right subclavian vein) during TEE, only the right cavities were filled. Neither TEE nor TTE allows the visualization of the PLSVC itself.

Conclusion

This case illustrates the management of an adult vvECMO with the reinjection cannula in a PLSVC, which is rare but the most common anomaly of the major veins.

Even if, in this case, it allowed adequate oxygenation of the patient and weaning from vvECMO, this insertion was complicated by a thrombosis of the PLSVC after removal of the cannula. Clinicians should be aware of this anomaly and the possible associated cardiac malformations, as well as of the multimodal imaging techniques that could help to confirm the diagnosis. Clinicians should avoid placement in the PLSVC, but if a catheter is inadvertently placed in the PLSVC despite appropriate management (eg, TEE, TTE, or fluoroscopy), the clinician should weigh the risk-benefit ratio of removing and replacing the cannula, especially if the ECMO

circuit is functioning properly. If removal is necessary, consider a bifemoral approach or the RIJ vein using the site of the previous catheter, and run the continuous venovenous hemofiltration on the ECMO circuit, if needed.

Declaration of competing interest

None.

CRediT authorship contribution statement

Arnaud Robert: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Conceptualization. **Pauline Vanesse:** Investigation. **Maria-Luiza Luchian:** Writing – review & editing, Supervision, Investigation. **Ovidiu Vornicu:** Investigation. **Gauthier Nendumba:** Investigation. **Aurélie Leroux:** Investigation. **Sarla Remacle:** Investigation. **Patrick M Honore:** Supervision. **Pierre Bulpa:** Writing – review & editing. **Isabelle Michaux:** Writing – review & editing, Supervision.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1053/j.jvca.2024.09.020.

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