Case Reports

Malposition of the Extracorporeal Membrane Oxygenation Venous Cannula in an Accessory Hepatic Vein

Hadrien Winiszewski, MD;* Andrea Perrotti, MD;†§ Sidney Chocron, MD, PhD;†§ Gilles Capellier, MD, PhD;*‡§ Gaël Piton, MD, PhD*§

*Medical Intensive Care Unit, †Cardiac Surgery Unit, University Hospital, Besançon, France; ‡Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Faculty of Medicine, Nursing and Health Sciences, Clayton, Australia; and §Research Unit EA 3920 and SFR FED 4234, University of Franche Comté, Besançon, France

Abstract: We report a case of a refractory cardiogenic shock secondary to myocardial infarction in a 70-year-old patient requiring femoral venoarterial extracorporeal membrane oxygenation (VA-ECMO). At initial transesophageal echocardiography, the venous cannula tip was seen in the inferior vena cava (IVC), but not in right atrium. On day 8, ultrasonic examination identified that the end of the venous cannula was in the hepatic vein (HV). Despite such malposition, no disturbance in extracorporeal membrane oxygenation (ECMO) venous return was observed. Moving or replacing the cannula was considered a high-risk maneuver potentially resulting in hepatic laceration with hemoperitoneum. Because of adequate venous drainage, allowing sufficient blood flow, venous cannula repositioning was delayed until day 10, when a ventricular defect was repaired and ECMO was weaned off. At the time of VA-ECMO implantation, the venous cannula has to be positioned in the right atrium using real time echo monitoring. Visualization of the guide wire in the IVC but not in the right atrium is insufficient to ensure appropriate venous cannula positioning. Indeed, either accidental catheterization or cannula migration into the HV is possible during ECMO. Health care professionals dealing with ECMO have to be aware of this possible malposition, to correct it and prevent insufficient venous drainage or traumatic complications. Keywords: shock, extracorporeal membrane oxygenation, echocardiography.

CASE REPORT

A 70-year-old patient was admitted to the Intensive Care Unit for cardiogenic shock 24 hours after a myocardial infarction complicated by a post-infarct ventricular septal defect. No medical history was available for the patient, but on examination it was evident that he was a smoker and overweight (1.78 m, 100 kg). Despite circumflex artery angioplasty, inotropes, and Impella™ device placement (Abiomed, Danvers, MA), the cardiovascular status continued to decline and the decision was made to initiate extracorporeal membrane oxygenation (ECMO) as a bridge to recovery of the ischemic myocardium. The venous and arterial cannulae were inserted using the cut down technique. Venous cannula placement in the inferior vena cava (IVC) was visualized using transesophageal echocardiography. The right femoral vein was cannulated using a 25 French 3 55 cm cannula (HLS; Maquet®, Hirrlingen, Germany). The right femoral artery was cannulated using a 19 French 3 23 cm cannula (HLS, Maquet®). The heparin-coated ECMO circuit included a Revolution™ pump and Eos ECMO™ oxygenator (Sorin®, Mirandola, Italy). Once the ECMO circuit was ready and connected, blood flow was initiated at 4.2 L/min at 2,400 RPM. Because of the lack of high negative pressures at the targeted blood flow, venous cannula position was deemed appropriate. Continuous intravenous infusion of unfractionated heparin was started to obtain an anti-Xa
activity between 0.3 and 0.4 UI/mL. On day 4, the Impella device was removed because of bacterial contamination of the incision site and in the blood. Daily ultrasonography monitoring showed an increase of pericardial effusion, with progressive compression of the right cavities. As no organ dysfunction was noted under ECMO, and because of the hemorrhagic risk because of anticoagulation, pericardial drainage was not performed. During a global ultrasonic examination on day 8, the end of the venous cannula was found to be located in the accessory hepatic vein (HV) (Figure 1). Because of adequate venous drainage, allowing sufficient blood flow, venous cannula repositioning was delayed until day 10, when a ventricular septal defect repair was performed on cardiopulmonary bypass. After transient change to normal cardiopulmonary bypass for the surgical procedure, ECMO was weaned off in the operating room. Pericardial fluids were evacuated at the same time, and the source was undefined. At post-operative day 7, the patient experienced cardiogenic shock which was treated with the insertion of veno-arterial ECMO (VA-ECMO) using the left femoral vein and artery. This time the venous cannula was positioned correctly in the right atrium. The patient was supported for 7 days without incident and was weaned from mechanical support. He died 1 week later because of septic shock of unknown source, as cultures were negative.

**DISCUSSION**

VA-ECMO is a life-saving type of circulatory support. Optimal performance of ECMO requires the correct positioning of the arterial and venous cannula. Transesophageal echocardiography is a key tool for the positioning of the venous cannula (1,2). Health care professionals, including perfusionists, surgeons, anesthesiologists, and intensive care physicians should understand pitfalls and checks to ensure a smooth insertion and initiation of ECMO. Indeed, to ensure maximal venous drainage and ECMO pre-load, the venous cannula extremity should be placed into the right atrium, or at the superior vena cava/right atrium junction. Under conditions of hypovolemia and/or intra-abdominal hypertension, a venous cannula positioned in the IVC can lead to inadequate venous return to the ECMO pump. Incorrect placement of the venous cannula in the IVC can also cause inferior vena collapse due to excessive negative pressure, decreasing venous return and ECMO blood flow (3). If IVC collapse persists despite correction of hypovolemia or intra-abdominal hypertension, correction will require repositioning the venous cannula into the right atrium. This repositioning increases the risk of infection at the femoral insertion site (4).

We report the first case of accidental catheterization or cannula migration during ECMO into an accessory HV by the ECMO venous cannula. It is possible that the cannula tip was in the IVC at the time of insertion and then migrated into the HV during repositioning or patient transition between beds. Such malposition might be associated with two types of complications. First, it could be responsible for insufficient pump preload and reduced ECMO blood flow. In the present case, we hypothesized that pump preload was sufficient because of the presence of pericardial tamponade. The pericardial tamponade resulted in IVC dilation which allowed sufficient flow into the multi-perforated venous cannula. A second complication could be associated with repositioning of the venous cannula. In this case repositioning of the venous cannula toward the right atrium had the risk of causing liver laceration with potentially lethal hemoperitoneum and hemorrhagic shock. Therefore, ruling out the malposition of the venous cannula in a HV is mandatory before repositioning. Previous cases of malposition of the venous cannula have been reported (5), including location in the coronary sinus (6), or trans-septo-atrial positioning (7). Although HV obstruction by ECMO double-lumen cannula outflow has been reported (8), we describe the first case of accidental catheterization of an accessory HV by the ECMO venous cannula. In the present case, initial transesophageal echocardiography incorrectly located the venous cannula in the IVC. On the contrary, trans-hepatic ultrasonography performed on the right side of the abdomen, correctly visualized the venous cannula extremity in a HV. This trans-hepatic window might be of interest among patients of cardiac surgery with dressings limiting the access to a subcostal view (9). Trans-hepatic ultrasonography might be an interesting complement to transesophageal echocardiography for verification of the appropriate position of the venous cannula and is less invasive than transesophageal echocardiography.

![Figure 1. Trans-hepatic view of the extracorporeal membrane oxygenation venous cannula. Ultrasonography performed on the right side of the abdomen showing the ECMO venous cannula in the IVC and its extremity in an accessory HV.](image-url)
At the time of VA-ECMO implantation, the venous cannula has to be positioned in the right atrium using real time echo monitoring. Visualization of the guide wire in the IVC but not in the right atrium is insufficient to ensure adequate venous cannula positioning. As demonstrated in this case report, accidental catheterization of the HV is possible because of the inability to fully visualize the IVC using transesophageal echocardiography. When inserting the venous femoral cannula the provider assisting with the echography should realize that the cannula introducer can be between 10 and 15 cm longer than the cannula. A less experienced echo provider might not fully understand the consequences of the difference in the length of the introducer and cannula. To ensure the correct placement of the cannula, the introducer should be pulled back and the cannula position reconfirmed without the introducer potentially masking the position on echography. Showing the cannula to the echo provider before insertion can also help with their ability to help guide cannula placement. Health care professionals dealing with ECMO have to be aware of this type of malposition of the venous cannula, the consequences to ECMO flow, and the potential traumatic complications associated with repositioning.

REFERENCES