Transition of femoral-jugular to dual-stage left subclavian without discontinuation of extracorporeal membrane oxygenation

Ernest Chan[1], Patrick Chan[1], Takashi Harano[1], and Pablo Sanchez[1]

[1]University of Pittsburgh Medical Center

June 8, 2020

Abstract

Extracorporeal membrane oxygenation (ECMO) is a technology that has allowed for further cardiopulmonary support in the setting of respiratory failure refractory to mechanical ventilation. While it has evolved since its first description, one area of improvement continues to be its implementation. With advancements in cannulation techniques, in recent years, there has been a plethora of new cannulas that has been introduced to the market. For urgent venous-venous cannulation, the right internal jugular vein along with either femoral veins remain the most utilized strategy due to minimal need for imaging support. This allows for safe bedside cannulation. However, as the number of days of ECMO support continue to increase bridging patients to an easier to ambulate and more comfortable cannulation strategy is preferred. Therefore, we describe a method for bridging right jugular-femoral cannulation to left subclavian placement of the CrescentTM Dual Lumen Catheter without interrupting ECMO support.

INTRODUCTION

Venovenous (VV) extracorporeal membrane oxygenation (ECMO) has become a viable treatment and standard of care for patients with respiratory failure refractory to mechanical ventilatory support. The introduction of a dual lumen cannula has provided us with the flexibility in cannulation strategy. With the dual lumen cannula, this offers the ability to require the need for cannulation at only a single site as it is equipped with separate lumens for drainage and infusion. In this report, we outline a technique used for bridging right jugular-femoral cannulation to left subclavian vein using the Crescent^{TM} Jugular Dual Lumen Catheter without interrupting ECMO support.

CASE REPORT

A 53-year-old female was transferred for acute respiratory failure and intubated upon arrival. A significant bronchopleural fistulas (BPF) compromised mechanical ventilatory support so she was placed on VV-ECMO (right internal jugular vein 17-Fr inflow cannula with a 23-Fr drainage multistage right femoral venous cannula). For 6 weeks, she improved but her extensive BPF required continued extracorporeal support. The multidisciplinary ECMO team agreed on conversion to a single dual lumen cannula as this will allow better mobility and improve her comfort. We decided to access the left subclavian vein as this will allow us to transition cannulation strategies without interrupting her ECMO circuit or changes in the ventilatory support.

Technique

Under fluoroscopy guidance in the operating room, the left subclavian was percutaneously accessed with Seldinger's technique. An Amplatz Super Stiff guidewire (0.035 inch ? 260 cm; Boston Scientific, Natick, MA) was positioned into the right atrium and inferior vena cava. After serial dilation, the 28 French Crescent^{TM} Jugular Dual Lumen Catheter (Medtronic, Minneapolis, Minnesota) was advanced under fluoroscopic and

transesophageal echocardiographic guidance with the infusion jet facing the tricuspid valve. Placement of the Crescent^{TM} Catheter was confirmed while maintaining full ECMO support from the previously circuit to ensure patient stability throughout the procedure **(Figure 1)** . Once positioned, the previous cannulas were clamped and removed after properly splicing the new dual lumen cannula to the ECMO circuit **(Figure 2A and B)** .

Since the conversion of cannulation strategies, the patient continued to improve. Her remaining BPF have healed and her activity level continues to improve each day.

DISCUSSION

ECMO affords us with the ability to treat patients with respiratory failure refractory to mechanical ventilatory support. However, it is associated with a number of complications that may require additional operations and even death.[1,2] Therefore, patients who require prolonged intubation are encouraged to ambulate and this has been associated with improved outcomes and overall health care costs.[3,4]

Cannulation is one of the first steps of ECMO initiation that is associated with many complications especially in the setting of percutaneous access of multiple blood vessels.[5,6] The use of subclavian arterial access was first described in 1993 by McGough and colleagues in for venoarterial support in an infant along with cannulation of the right internal jugular vein. Shafii et al. in 2012 describes subclavian vein access for placement of the Avalon (Avalon Laboratories, Rancho Dominguez, CA) bicaval dual-lumen Elite cannula.[7] In their anecdotal experience, they found that patients were more comfortable and were more easily encouraged to be mobile. In the current case, there are several advantages to utilizing a single site subclavian vein cannulation for ECMO support. Due to her predisposition for poor healing, it was evident that she would require a prolonged course of ECMO support. This strategy improved the patient's mobility to minimize further deconditioning. From a technical standpoint, the conversion to single site subclavian vein cannulation can be performed while preserving previously placed ECMO circuits until while proper placement of the new cannula is achieved to safely support the patient throughout the procedure. In addition, this cannulation strategy offers flexibility for future cannulation conversions as both groin sites as well as the right neck are easily accessible for the introduction of additional cannulas in both a controlled and emergent fashion if necessary.

In this manuscript we report some modifications to previous literature describing the subclavian vein access and Crescent^{TM}cannula use. While our approach echoes that of Shafii and colleagues, we believe this cannula has important differences to note with the Avalon. The Avalon has a maximum insertion length of 31 cm and ranges from 13 to 31 Fr allowing for use in the pediatric population. However, all Crescent Catheter[?] 28 Fr are all 34 cm in length which can be helpful in larger patients. In addition, because of its design, the Crescent Catheter has the ability to achieve higher flow rates with a lower pressure loss according to the manufacturing website compared to the Avalon, which may provide a distinct theoretical advantage in lower rates of hemolysis and recirculation. Ultimately additional studies will have to be performed in order to adjudicate these statements.

There are several clinical aspects to consider with this cannulation strategy. First, we recommend performing this cannulation conversion strategy in the operating room with both fluoroscopic and echocardiographic guidance to ensure proper positioning is achieved for adequate drainage and infusion. Second, while Shafii et al. reports easier maintenance by nursing staff, special care is needed to minimize infection especially in the setting of a tracheostomy which is in close proximity. Therefore, sterile techniques and close monitoring of the cannulation site is necessary. Third, in order to minimize the morbidity of limb ischemia, additional access to the left upper extremity should be limited. Lastly, it is important to note the length of cannulas used for this procedure. Given the longer course of the left subclavian vessels, it is important to obtain adequate length to allow for proper alignment of the reinfusion port to the tricuspid valve which can be seen under fluoroscopy.

In conclusion, the use of the Crescent^{TM} Dual-Lumen Catheter at the left subclavian vein as a single cannulation site for VV-ECMO support is a safe and viable. This is a safe and viable option for veno-venous ECMO cannulation. It allows for both adequate drainage and reinfusion and can be used to maximize

mobility in patients who require prolonged extracorporeal support.

REFERENCES

1. Zangrillo A, Landoni G, Biondi-Zoccai G, et al. A meta-analysis of complications and mortality of extracorporeal membrane oxygenation.*Critical care and resuscitation : journal of the Australasian Academy of Critical Care Medicine.* 2013;15(3):172-178.

2. Abrams D, Javidfar J, Farrand E, et al. Early mobilization of patients receiving extracorporeal membrane oxygenation: a retrospective cohort study. *Critical care (London, England).* 2014;18(1):R38.

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(5):1213-1218.

4. Rehder KJ, Turner DA, Hartwig MG, et al. Active rehabilitation during extracorporeal membrane oxygenation as a bridge to lung transplantation.*Respiratory care.* 2013;58(8):1291-1298.

5. Conrad SA, Grier LR, Scott LK, Green R, Jordan M. Percutaneous cannulation for extracorporeal membrane oxygenation by intensivists: a retrospective single-institution case series. *Critical care medicine.* 2015;43(5):1010-1015.

6. Rupprecht L, Lunz D, Philipp A, Lubnow M, Schmid C. Pitfalls in percutaneous ECMO cannulation. *Heart Lung Vessel.*2015;7(4):320-326.

7. Shafii AE, McCurry KR. Subclavian insertion of the bicaval dual lumen cannula for venovenous extracorporeal membrane oxygenation. *Ann Thorac Surg.* 2012;94(2):663-665.

FIGURE LEGEND

Figure 1

Crescent cannula (red X) is advanced under fluoroscopic and echocardiographic guidance while the previous ECMO cannulas (**) are preserved to ensure stability of the patient during the procedure.

Figure 2A and B

Chest x-ray (A) and gross(B) look at the final configuration of the single site left subclavian vein cannulation with the Crescent Catheter for veno-venous ECMO support.