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POINT-OF-CARE ULTRASOUND–GUIDED PERCUTANEOUS CANNULATION OF EXTRACORPOREAL MEMBRANE OXYGENATION: MAKE IT SIMPLE

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☐ **Abstract—Background: Cannulation of the great vessels is required for extracorporeal membrane oxygenation (ECMO). Currently, there is no guideline for optimal imaging modalities during percutaneous cannulation of ECMO. Objective: The purpose of this study was to describe percutaneous cannulation guided by point-of-care ultrasound (POCUS) for ECMO and compare it with fluoroscopy and landmark guidance. Methods: Three groups (POCUS-, fluoroscopy-, and landmark-guided) of percutaneous cannulation for ECMO were analyzed retrospectively in a tertiary academic hospital. In the POCUS-guided group, visual confirmation of guidewire and cannula by ultrasound in both the access and return cannula were essential for successful cannulation. Fluoroscopy- and landmark-guided groups were cannulated with the conventional technique. Results: A total of 128 patients were treated by ECMO during the study period, of which 94 (73.4%) cases were venoarterial ECMO. This included 56 cases of extracorporeal cardiopulmonary resuscitation. Also, there were 30 (23.4%) cases of venovenous ECMO and 4 (3.1%) cases of venoarteriovenous ECMO. A total of 71 (55.5%) patients were cannulated under POCUS guidance, and 43 (33.6%) patients were cannulated under fluoroscopy guidance and 14 (10.9%) patients were cannulated by landmark guidance. No surgical cut downs were required. Misplacement of cannula occurred in 3 (2.3%) cases. All three occurred in the landmark-guided group. Conclusions: POCUS-guided cannulation is comparable to fluoroscopy-guided cannulation in terms of avoiding cannula misplacement. In our experience, POCUS-guided cannulation is a useful strategy over fluoroscopy- and landmark-guided cannulation during peripheral ECMO.** © **2017 Elsevier Inc. All rights reserved.**

☐ **Keywords—extracorporeal membrane oxygenation; cannulation; ultrasonography; fluoroscopy; transthoracic echocardiography; transesophageal echocardiography**

INTRODUCTION

Extracorporeal membrane oxygenation (ECMO) support is now established as a treatment for refractory cardiopulmonary failure due to potentially reversible causes, and its use has been increasing globally (1). Cannulation via large vessels is the technique for initiating ECMO support. This cannulation is often performed percutaneously (2). It can be performed using various imaging guidance, including transthoracic echocardiography (TTE), transesophageal echocardiography (TEE), and fluoroscopy, by physicians with various background specialties, including cardiac surgery, intensive care medicine, and emergency medicine (3–5).

Although a recent paper on ECMO for respiratory failure recommended the use of echocardiography during cannulation, whether TTE or TEE is a better modality

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has not been clearly addressed (6). Previous studies have reported that TEE-guided cannulation is feasible (7,8). Fair et al. reported the feasibility of TEE in emergency department (ED) ECMO program (9). However, TEE also has disadvantages because of its need for additional training and its invasiveness compared to TTE (10).

Fluoroscopy can also be used during cannulation procedures. However, it has inherent disadvantages, including the need for transport to catheterization suites, risk of radiation, and contrast-induced nephropathy.

Currently, there is no guideline for optimal imaging modalities during percutaneous cannulation of ECMO support. Furthermore, data on cannulation-related outcomes by imaging modality are limited.

Because efficacious percutaneous cannulation relies on safe, fast, and reliable identification of guidewire and cannula placement in great vessels, we hypothesize that point-of-care ultrasound (POCUS) might be superior to fluoroscopy in terms of availability and technical ease.

The aim of this study was to evaluate cannulation success and misplacement according to different imaging modalities.

METHODS

Study Design and Choice of Imaging Modality

A retrospective cohort study was conducted to describe percutaneous cannulation guided by POCUS for ECMO and compare it with fluoroscopy and landmark guidance. Data from 128 patients in a single tertiary academic hospital with 1355 beds who underwent peripheral cannulation for ECMO support between March 1, 2013 and November 30, 2016 were evaluated. Peripheral cannulation for ECMO support was evaluated by dividing into three groups based on the imaging modality chosen. The groups were POCUS-, fluoroscopy-, and landmark-guided. The POCUS group was compared to the other groups for frequency of misplacement of the cannula. The choice of imaging guidance modality for cannulation was not randomized and was selected by the doctor performing the cannulation. During the study period, intensivists assumed primary responsibility for ECMO cannulation in both EDs and intensive care units (ICUs), while cardiologists performed venoarterial (VA) ECMO cannulation in cases where intensivists were not available, for timely cannulation in cardiogenic shock or cardiac arrest due to cardiac origin, typically in patients with acute myocardial infarction who needed further intervention, such as percutaneous coronary intervention in catheterization unit. Venovenous (VV) ECMO cannulation was done by intensivists, exclusively. In three groups, the access and return cannula were inserted in sizes ranging from 19Fr to 23Fr and 15Fr to 17Fr, respectively.

Setting and Procedures of POCUS-Guided Cannulation

POCUS-guided cannulation of ECMO was performed by two intensivists (one with background specialty of cardiac surgery and the other one with background of emergency medicine, both with POCUS use confidence in daily clinical practice) in the ED and ICU using an ESAOTE US system (Esaote, Genova, Italy) or a LOGIQ P9 US system (LOGIQ^{TM} P9; GE Healthcare, Wauwatosa, WI) equipped with a 1.3- to 4.0-MHz phased array probe, a 1.0- to 6.0-MHz convex probe, and a 5.0- to 13.0-MHz linear probe.

VA ECMO and Extracorporeal Cardiopulmonary Resuscitation

Femoral vessels were identified by POCUS and accessed with a needle by Seldinger technique. Femoral venipuncture was always attempted first. Guidewire placement in the right atrium-inferior vena cava (RA-IVC) junction on subxiphoid view before sequential dilatation was confirmed by POCUS (Figure 1). When in doubt, back-and-forth motion of guidewire was used to make it easy to identify the presence of guidewire and exclude artifact effect.

Arterial cannulation proceeded under POCUS guidance. Guidewire in abdominal aorta was confirmed by rotating and tilting transducer in the same subxiphoid view (Figure 2). Distal perfusion catheterization was attempted before arterial cannulation whenever possible. Pre-emptive distal perfusion cannula was placed to decrease lower-extremity ischemic complications.

Under extracorporeal-cardiopulmonary resuscitation (E-CPR) situation, the transducer was rotated and tilted

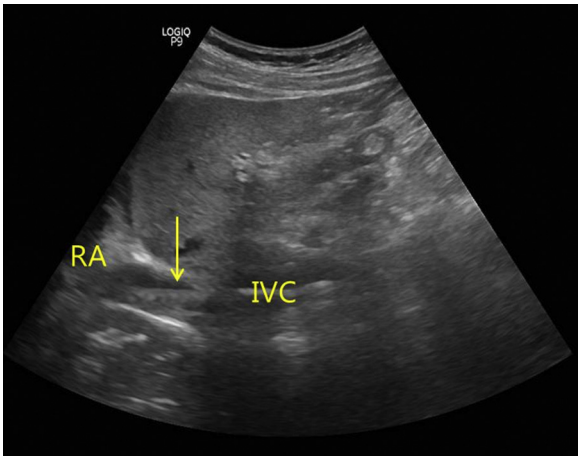

Figure 1. In access cannulation, the guidewire (arrow) is visible within the right atrium (RA)–inferior vena cava (IVC) junction in subxiphoid view.