Central Cannulation as a Viable Alternative to Peripheral Cannulation in Extracorporeal Membrane Oxygenation

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Arterial cannulation for veno-arterial (VA) extracorporeal membrane oxygenation (ECMO) is most commonly established via the aorta, axillary, or femoral vessels, yet their inherent complications are not well characterized. The purpose of this study was to compare the outcomes and complication rates of central vs peripheral cannulation. Adult patients undergoing VA ECMO between June 2009 and April 2015 were reviewed in this retrospective single-center study. Patient characteristics, clinical outcomes, and details related to deployment were extracted from the medical record. Complications and survival rates were compared between patients by cannulation strategy. Of 131 VA ECMO patients, there were 36 aortic (27.5%), 16 axillary (12.2%), and 79 femoral (60.3%) cannulations. Other than a lower mean age with femoral cannulations (53.9 ± 13.9 years) vs aortic (60.3 ± 12.2 years) and axillary (59.8 ± 12.4 years) ($P = 0.032$), the baseline patient characteristics were not statistically different. Central cannulation was more common in patients transferred from outside facilities (74.3% central vs 51.6% peripheral) ($P = 0.053$). Seven of 36 aortic cannulations were via anterior thoracotomy (19.4%). Forty of 131 patients underwent extracorporeal cardiopulmonary resuscitation (30.5%), 33 of whom were femorally cannulated. Peripheral cannulation carried a 29.5% rate of vascular complications compared with an 11.1% rate of mediastinal bleeding with central cannulation. Incidence of stroke and overall survival between groups were not statistically different. Central cannulation is a viable alternative to peripheral cannulation. Central cannulation avoids high rates of extremity morbidity without causing significant risks of alternative morbidity or death.

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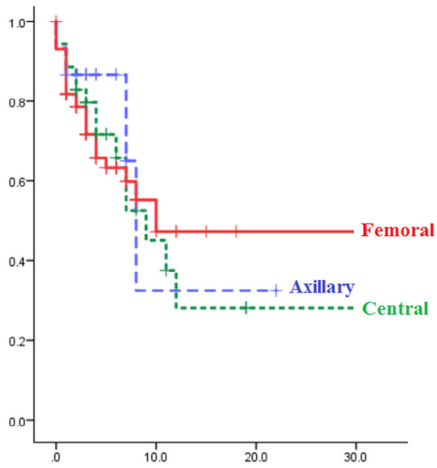

Overall survival by cannulation strategy.

Central Message

Central cannulation avoids the extremity morbidity of peripheral cannulation without adding significant morbidity or risk of death.

Perspective Statement

Peripheral cannulation for extracorporeal membrane oxygenation is often preferred over central cannulation due to its less invasive nature and ease of technique. This study describes an approach that favors central cannulation and compares the complication profiles between peripheral and central cannulation. Our results demonstrate the utility of early central cannulation in a subset of patients.

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INTRODUCTION

Utilization of veno-arterial (VA) extracorporeal membrane oxygenation (ECMO) as mechanical circulatory support (MCS) or respiratory support for adults in cardiopulmonary failure is increasing.[1] Various cannulation strategies for VA ECMO are possible; these are generally categorized as either central or peripheral.[2] Central cannulation involves direct cannulation of the aorta, with venous drainage typically achieved via the right atrium. In contrast, peripheral cannulation involves arterial cannulation of either the axillary or the femoral artery, with venous drainage typically from either the femoral or internal jugular veins.[3]

The decision to use peripheral vs central cannulation for VA ECMO is based on patient and logistical factors. Primarily, the stability of the patient and the location of ECMO cannulation often dictate cannulation strategy. Central cannulation is not routinely performed outside of the operating room (OR), with the exception of patients with post-cardiotomy shock. In contrast, femoral cannulation is frequently used in patients who are undergoing cardiopulmonary resuscitation or are too unstable for transport to the OR. In the subset of patients who are stable for transport to the OR, there are few data to guide the decision between central and peripheral cannulation.[4] In some cases, patient characteristics may favor one cannulation strategy over another. For example, a patient with decompensated heart failure and left ventricular (LV) distention may be best supported with central cannulation and LV venting. Similarly, a patient with prior sternotomy may be better supported with peripheral cannulation in an effort to avoid the risks associated with redo dissection of the mediastinum.

Historically, central cannulation has been avoided due to its invasiveness and presumed higher rates of complications. However, peripheral cannulation can also be quite morbid. Specifically, there is a significant risk of ischemic vascular complications.[5] Given the lack of direct comparison studies in the literature and consensus guidelines, there remains a need to further characterize the outcomes and complication profiles of central vs peripheral cannulation. Furthermore, using mini-anterior thoracotomy for central cannulation may be the most appropriate strategy in some patients (Video 1).[6] The purpose of this study was to compare the outcomes and complication rates of central vs peripheral VA ECMO cannulation and describe an algorithmic approach to determining the most suitable cannulation strategy.

METHODS

Patient Selection

An institutional review board approval was obtained for this single-center retrospective study. We identified patients ≥18 years of age who underwent VA ECMO cannulation at our institution between June 2009 and April 2015. Indications for ECMO included cardiac arrest, decompensated heart failure, post-cardiotomy cardiogenic shock, and severe respiratory failure resulting in hemodynamic instability. Post-cardiotomy shock was defined as refractory cardiogenic shock within 7 days of cardiac surgery necessitating MCS. Patients cannulated at outside facilities and transferred to our institution for ongoing management were also included in the study. Patient characteristics, technical characteristics of the ECMO circuit, and patient outcomes including in-hospital mortality rates, clinical events, and incidence of selected complications were recorded. Complications were defined according to the Society of Thoracic Surgeons Adult Cardiac Surgery Database definitions. We also defined vascular complications as limb ischemia requiring placement of a distal perfusion cannula (excluding those with prophylactic distal perfusion cannula placement), arterial thrombectomy, fasciotomy, amputation, bleeding requiring cannula site exploration, mechanical vessel injury requiring nonroutine arteriography, and conversion to an alternative cannulation method due to limb malperfusion. Clinically significant coagulopathy was defined as diffuse, low-volume blood loss (ie, "oozing") from multiple sites, to be differentiated from major bleeding events from single sites. Circuit malfunction was defined as the need for any circuit component exchange due to inadequate function, thrombus, or sensor malfunction. We divided our cohort into 3 groups: (1) those undergoing central arterial cannulation as defined by direct aortic cannulation, (2) those undergoing peripheral cannulation via the axillary artery, and (3) those undergoing peripheral cannulation via the femoral artery.

Statistical Analyses

Categorical variables were compared between groups using Fisher exact test, and continuous variables expressed as means were compared using Student's t-test. Kaplan-Meier techniques were used to demonstrate overall unadjusted survival among the 3 cohorts and were compared using the Breslow test. Statistical analyses were completed using SPSS Statistics Version 23 (IBM, Armonk, NY).

Cannulation Strategy

Cannulation strategy is often dictated by the location of the patient; specifically, unstable patients who are not in the OR will be often peripherally cannulated at the bedside. However, patients who are stable enough for transport will be cannulated in the OR. In that circumstance, we will consider all patient characteristics when selecting between central and peripheral cannulation. Figure 1 represents our algorithm for