Veno-Arterial ECMO in Critically Ill Patients Affected With COVID-19 and Resistant to Supportive Respiratory Cares: An Iranian Experience

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Received: 26 Oct. 2021; Accepted: 12 Mar. 2022

The novel coronavirus-2019 novel coronavirus (2019-nCoV), currently known as COVID-19, has been emerged in Wuhan, China. This highly contagious infectious disease passes an incubation period of about 2 to 14 days with a subsequent transmission through respiratory droplets and close contact. The natural course of the disease ranges from mild to severe deterioration, hemodynamic collapse, and death. The majority of cases suffer from cough, fever, shortness of breath, and pneumonia. The COVID-19 disease entity could be a multi-organ failure (MOF) with involvement of the brain, kidneys, liver, and heart due to tissue hypoxia (1). Bearing in mind that tissue hypoxia is the major culprit, the initial respiratory supports pass through supportive respiratory care. If these measures fail, the patient should undergo mechanical ventilation. Finally, extracorporeal membrane oxygenation (ECMO) is considered in critically ill patients with refractory hypoxemia despite the above-mentioned measures (2). Since the mortality rate of this virus is about 2%, the survival of some critically ill patients is of great importance in decreasing the mortality rate (2). Thus, ECMO seems to be the last resort, but since there is severe tissue hypo-oxygenation and MOF due to the length of disease course that may be prolonged, Veno-Venous ECMO might be inefficient or may not be sufficient. In addition, anticoagulation is essential while using Veno-Venous ECMO as a non-endothelialized system, which is dangerous in the setting of already bleeding complications of COVID-19 (3). On the other hand, subsiding anti-coagulation means Veno-venous ECMO failure due to venous thrombosis (3). In the setting of acute circulatory failure and MOF, peripheral Veno-arterial ECMO is suggested to restore tissue perfusion and organ function (4). But it has its own disadvantages, mainly due to cerebral under perfusion. The retrograde flow support provided by peripheral VA-ECMO travels from the iliac or femoral arteries towards the thoracic aorta and counteracts in the watershed region at anywhere between the diaphragm and aortic root based on the output of left ventricle (LV) compared to ECMO flow. The more distal watershed region is seen in the setting of high antegrade LV output compared to ECMO flow and vice versa. In the watershed region distal to the left subclavian artery, the risk of significant hypoxemia of the heart, brain, and upper extremities would be noticeable. Harlequin syndrome, also known as a north-south syndrome, occurs in extreme cases, which manifests by Harlequin-like appearance due to lower body hyperoxia and upper body hypoxemia (5). Thus, to overcome this obstacle in the setting of preserved cardiac function, VA-ECMO uses an antegrade approach through antegrade cannulation. In this way, the cannula is in the same path with cardiac output, which is associated with a lower risk of Harlequin syndrome (6). For this purpose, both percutaneous and open approaches are available. For percutaneous approach, brachial artery cannulation with perfusion of the proximal part using Y connection through guide passage from proximal part and then distal part of the arch is performed. Long size cannulation using the Slendiger method to place the tip of the cannula in the aortic arch needs echocardiography-guide. Y-connection is used to connect it with a separate line and pass it through the guidewire of the proximal part of the artery. In an open surgical approach, a 6F Dacron graft may be sutured to the side of the subclavian artery that can perfuse distal and proximal of the artery. Bandage may be needed to adjust tightness of proximal site of graft in the case of hand congestion (7). For both methods, we used

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and recommend application of the smallest cannula size that could provide the appropriate flow. Another recommendation is extraction of arterial cannula during patient weaning after recovery from ECMO through open surgical approach to estimate the flow at the proximal and distal sites of cannula and exit the possible thrombus with Fugarti catheter and/or repair the possible intimal flap by vascular surgeon. This will diminish the risk of iatrogenic arterial damage. The procedure is depicted in Figure 1.

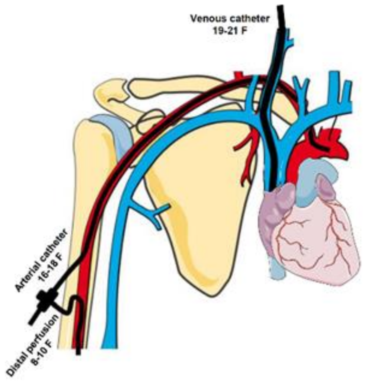

Figure 1. The illustration of the antegrade approach for veno-arterial extracorporeal membrane oxygenation. Percutaneous exposure of the right brachial artery and right internal jugular vein facilitates cannulation for antegrade perfusion during veno-arterial ECMO. A small 8F cannula is used to perfuse the distal brachial artery

In conclusion, most critically- ill cases affected with COVID-19 suffer from respiratory distress and seem to have preserved cardiac function. Parallel to other available therapeutic strategies in this setting, we recommend VA-ECMO implanted through an antegrade approach via cannulation of the brachial or subclavian artery and internal jugular vein using the smallest cannula size that could provide the appropriate flow rate. Indeed, the extraction of arterial cannula after patient recovery should be performed surgically. Regarding many heart transplantation centers in our country, we have good experiences in ECMO insertion and management with relatively good results. Finally, it is worth saying that these are our recommendations as physicians involved in the treatment of critically ill cases affected by COVID-19 by ECMO in our country, and further investigations and trials are needed.

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