Journal of Cardiology Cases xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Cardiology Cases

journal homepage: www.elsevier.com/locate/jccase

Case Report

Promising method for management of venoarterial extracorporeal membrane oxygenation: A case of severe heart failure successfully stabilized by "high-flow/vasodilation method"

Toru Kondo (MD)[a], Akinori Sawamura (MD, PhD)[a,*], Takahiro Okumura (MD, PhD)[a], Naoaki Kano (MD)[a], Ryota Morimoto (MD, PhD)[a], Naoki Watanabe (MD)[a], Hiroaki Hiraiwa (MD)[a], Tasuku Kuwayama (MD)[a], Yuki Sugiura (MD)[a], Tomoaki Haga (MD)[a], Shogo Yamaguchi (MD)[a], Kenji Fukaya (MD, PhD)[a], Tsuyoshi Yokoi (MD)[a], Kazuro Fujimoto (MD, PhD)[b], Masato Mutsuga (MD, PhD)[b], Tomo Yoshizumi (MD, PhD)[b], Naoyuki Matsuda (MD, PhD)[c], Akihiko Usui (MD, PhD)[b], Toyoaki Murohara (MD, PhD, FJCC)[a]

[a] *Department of Cardiology, Nagoya University Graduate School of Medicine, Nagoya, Japan*
[b] *Department of Cardiac Surgery, Nagoya University Graduate School of Medicine, Nagoya, Japan*
[c] *Emergency and Critical Care Medicine, Nagoya University Graduate School of Medicine, Nagoya, Japan*

ARTICLE INFO

Article history:
Received 10 March 2018
Received in revised form 18 April 2018
Accepted 7 May 2018

Keywords:
Extracorporeal membrane oxygenation
Heart failure
Dilated cardiomyopathy
Management

ABSTRACT

We report the case of a 58-year-old man with dilated cardiomyopathy who was hospitalized because of worsening heart failure. As his symptoms were refractory even with the administration of inotropes, he was given peripheral venoarterial extracorporeal membrane oxygenation (VA-ECMO) upon transfer to our hospital.

On admission, serum creatinine was 2.62 mg/dL and total bilirubin 10.8 mg/dL. The cannulas inserted were 16-Fr for infusion and 21-Fr for drainage. When the blood flow was increased to 2.14 L/min/m^2 to improve organ dysfunction, the aortic valve became continuously close with the mean arterial pressure of 85 mmHg. Therefore, we administrated vasodilators to decrease mean arterial pressure, or left ventricular afterload, which achieved opening aortic valve continuously. After the cannula sizes were scaled up to 18Fr for infusion and 24Fr for drainage to gain further blood flow, the aortic valve opened continuously and mean pulmonary pressure decreased.

Our strategy to maintain adequate flow rate of VA-ECMO using vasodilator, "high-flow/vasodilation method", achieved hemodynamic stability. Additionally, the concentration of serum creatinine and total bilirubin gradually decreased to within the normal range, although the patient succumbed 58 days after transfer to our hospital.

<**Learning objective:** Venoarterial extracorporeal membrane oxygenation (VA-ECMO) is often used as a first-line mechanical circulatory support in patients with severe heart failure. However, its management is difficult and not established. We discuss the efficacy and potency of our "high-flow/vasodilation method" in the management of VA-ECMO.>

Introduction

Peripheral venoarterial extracorporeal membrane oxygenation (VA-ECMO) is often used as first-line mechanical circulatory support (MCS) for cardiogenic shock because it can be initiated less invasively and more rapidly than surgical MCS [1]. However, the management of VA-ECMO is sometimes complicated and challenging in cases with very low cardiac function [2]. On one hand, the increase in support

* Corresponding author at: Department of Cardiology, Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya, Aichi 466-8550, Japan.
E-mail address: a-sawamu@med.nagoya-u.ac.jp (A. Sawamura).

https://doi.org/10.1016/j.jccase.2018.05.002
1878-5409/

blood flow often elevates left ventricular (LV) afterload and results in pulmonary congestion caused by insufficient LV unloading [3]. On the other hand, its reduction leads to insufficient tissue perfusion and multiple organ failure. To solve these problems, we propose a useful strategy to maintain adequate blood flow rate using vasodilators, or "high-flow/vasodilation method", for the management of VA-ECMO in patients with cardiogenic shock.

Herein we present the case of a male patient with severe heart failure whose hemodynamics was successfully stabilized by our "high-flow/vasodilation method."

Case report

A 58-year-old man, who had already been diagnosed with dilated cardiomyopathy at 49 years of age, complained of general fatigue and dyspnea at rest. He had been treated with cardioprotective agents and cardiac resynchronization therapy in accordance with standard clinical guidelines. Transthoracic echocardiography showed an LV ejection fraction of 15% and LV end-diastolic diameter of 75 mm with severe functional mitral regurgitation. His chest roentgenogram revealed pulmonary congestion, and he was hospitalized because of worsening heart failure. Since his symptoms continued to deteriorate despite continuous infusion of dobutamine, he was intubated and intra-aortic balloon pumping was initiated 20 days after admission. However, 28 days later he presented with oliguria caused by refractory cardiogenic shock, and VA-ECMO was initiated. The cannula sizes were 16Fr for infusion and 21Fr for drainage, via the right femoral vessels. At this point the patient was transferred to our hospital for management of his severe heart failure.

On arrival, the patient's mean arterial pressure (mAP) was 73 mmHg with pulse pressure of 10 mmHg, heart rate of 80 beats/min, and central venous pressure of 4 mmHg. His body weight and body surface area were 52.3 kg and 1.59 m^2, respectively. Dobutamine (4.7 μg/kg/min) and milrinone (0.13 μg/kg/min) were continuously infused under a blood flow rate of 1.57 L/min/m^2 (48 mL/min/kg) by a Capiox® centrifugal pump (Terumo, Tokyo, Japan) with a rotation rate of 2100 rpm. Pulmonary congestion remained apparent on the chest roentgenogram. His LV ejection fraction was less than 10% and the LV end-diastolic diameter was 83 mm on the transthoracic echocardiogram. Although his clinical status was critical end-stage heart failure, we decided not to convert VA-ECMO to an extracorporeal ventricular assist device since he was not a candidate for heart transplantation at that time. His serum creatinine presented higher than 2.0 mg/mL since 2 years previously, and chronic kidney disease met the exclusion criteria for heart transplantation in Japan. Because an implantable ventricular assist device is used only as a bridge to transplantation in Japan, the implementation of such a device was also not indicated.

We considered that the blood flow rate of VA-ECMO was insufficient because kidney function and liver function gradually worsened even after VA-ECMO initiation. Therefore, we increased the blood flow to 2.14 L/min/m^2 (65 mL/min/kg) with rotation of 2600 rpm. We also started continuous renal replacement therapy for the purpose of systemic volume optimization and oliguria. Infusion of milrinone was stopped because nonsustained ventricular tachycardia was documented. We concerned about the adverse effect of milrinone in patients with kidney injury. We started infusion of nitroglycerin (0.3 μg/min/kg) to reduce the cardiac afterload. On the next day (post-transfer day 2), however, the patient's pulse pressure disappeared while his mAP was as high as 85 mmHg. In addition, the transthoracic echocardiogram revealed continuous closure of aortic valve (Fig. 1A). We succeeded in keeping the aortic valve open after increasing the dose of nitroglycerin (0.9 μg/min/kg) to decrease mAP and reduce LV afterload (Fig. 1B). Thereafter we started carperitide and nicardipine infusion to maintain control of his mAP because the aortic valve closed easily when the mAP was more than 75 mmHg (Fig. 2).

Three days after the transfer, anemia caused by hemolysis progressed rapidly, and required repeated transfusion of red blood cells. Additionally, the persistent deterioration of hepatic dysfunction suggested the probability of inadequate organ perfusion. Therefore, we scaled up the size of the VA-ECMO cannulas to 18Fr for infusion and 24Fr for drainage to gain sufficient blood flow support. An antegrade 5-Fr arterial perfusion catheter was also inserted. The blood flow rose to 2.50 L/min/m^2 (2000 rpm), the aortic valve opened with every beat, and the mean pulmonary pressure decreased, which indicated that enough LV unloading was obtained by concomitant use of vasodilators. In addition, significant signs of hemolysis disappeared and no limb ischemia was observed.

The high-flow management using vasodilators, or "high-flow/vasodilation method" made it possible to maintain stable hemodynamics in the patient for approximately 2 months, leading to significant improvement in serum creatinine up to 0.48 mg/dL at 48 days after transfer (see Supplementary Figure). His aspartate aminotransferase and total bilirubin also decreased to normal values during the long-term management of VA-ECMO. Despite improvement in kidney function, we were unable to convert to an extracorporeal ventricular assist device because the patient had experienced multiple intracranial hemorrhage 11 days after transfer. He died 58 days after being transferred to our hospital.

Discussion

This case report demonstrates that controlling LV afterload with appropriate use of vasodilators enables stable high-flow management for a lengthy period in the cardiogenic shock patient by using VA-ECMO. Our "high-flow/vasodilation method" for VA-ECMO not only has the advantage of improving multiple organ failure but also

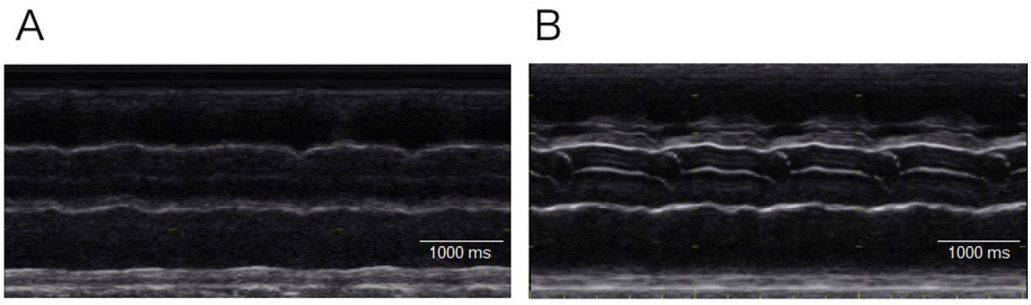

Fig. 1. M-mode findings at aortic valve level in transthoracic echocardiography. At the time of transfer to our hospital, the patient's mean arterial pressure (mAP) was 85 mmHg with the aortic valve continuously closed (A). After the use of vasodilotors, mAP was 70 mmHg and the aortic valve opened with every heart beat (B).

Please cite this article in press as: Kondo T, et al. Promising method for management of venoarterial extracorporeal membrane oxygenation: A case of severe heart failure successfully stabilized by "high-flow/vasodilation method". J Cardiol Cases (2018), https://doi.org/10.1016/j.jccase.2018.05.002