Successful treatment of large left ventricular thrombosis during extracorporeal membrane oxygenation (ECMO):a case report and review of the literature

Xueting Yang[1], Yijin Chen[1], Han Zeng[1], Lei Deng[1], Li Chang[1], Yi Li[1], Menglong Song[1], Yang Zhang[1], Wei Peng[1], Dong Wang[1], Hongqiong Peng[1], and Hua Jiang[1]

[1]Sichuan Province People's Hospital

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Xue-ting Yang, MM[1]**, Yi-jin Chen, MM[1,2,3]**, Han Zeng, MM[1]**, Lei Deng, MM[1], Li Chang, MM[1], Yi Li, MM[1], Meng-long Song, MM[1], Yang Zhang, MM[1], Wei Peng, MM[1], Dong-Wang, MM[1,2,3], Hong-qiong Peng, MM[1+], Hua Jiang, MD[1,2+]

1 Emergency intensive care unit, Sichuan Provincial People's Hospital, University of Electronic Science and Technology of China, No. 32, West Second Section, 1st Ring Road, Chengdu 610072, Sichuan, China*; 2 Institute for Emergency and Disaster Medicine, Sichuan Academy of Medical Science, Sichuan Provincial People's Hospital, School of Medicine, University of Electronic Science and Technology of China,* No. 32, West Second Section, 1st Ring Road, *Chengdu610072,* Sichuan, *China; 3 University of Electronic Science and Technology of China, Chengdu 6100054, China.*

+Corresponding Author: Hong-qiong Peng, Emergency intensive care unite, Sichuan Provincial People's Hospital, University of Electronic Science and Technology of China, No. 32, West Second Section, 1st Ring Road, Chengdu 610072, Sichuan, China. Tel: +86-28-87393496, Email: 2294398778@qq.com. Hua Jiang, Emergency intensive care unite, Sichuan Provincial People's Hospital, University of Electronic Science and Technology of China, No. 32, West Second Section, 1st Ring Road, Chengdu 610072, Sichuan, China. Tel: +86-28-87393881, Email: jianghua@uestc.edu.cn.

**These authors have contributed equally to this work

Author Contributions:

Xue-ting Yang: Writing-original draft.

Yi-jin Chen: Writing-original draft.

Han Zeng: Writing-original draft.

Lei Deng: Acquisition, analysis, or interpretation of data.

Li Chang: Acquisition, analysis, or interpretation of data.

Yi Li: Acquisition, analysis, or interpretation of data.

Meng-long Song: Acquisition, analysis, or interpretation of data.

Yang Zhang: Acquisition, analysis, or interpretation of data.

Wei Peng: Acquisition, analysis, or interpretation of data.

Dong-Wang: Writing-review and editing.

Hong-qiong Peng: Supervision.

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Conflict of interest statement

All authors have nothing to declare.

Data availability statement

The corresponding author's data supporting this study's findings are available upon reasonable request.

Consent

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

ORCID

Yi-jin Chen https://orcid.org/0009-0009-8075-1093

Key clinical message

We report the case that a fulminant myocarditis patient was treated with Venoarterial extracorporeal membrane oxygenation (VA-ECMO) and experienced a rare complication of left ventricular giant thrombosis. After anticoagulation alone without surgical intervention, the thrombosis disappeared. This case illustrates anticoagulant alone therapy is safe and effective on treatment of giant left ventricular thrombosis during ECMO.

Keywords: extracorporeal membrane oxygenation (ECMO), left ventricular (LV) thrombosis, anticoagulant.

Introduction

Extracorporeal membrane oxygenation (ECMO) is widely used to patients with fulminant myocarditis, severe heart failure or respiratory failure or combined cardiorespiratory failure. It has been more than 50 years since ECMO was first successfully used to save the patient's life. According to the return cycle, ECMO is classified by venoarterial extracorporeal membrane oxygenation (VA-ECMO) and venovenous extracorporeal membrane oxygenation (VV-ECMO). ECMO is a high-risk operation technique, which may cause fatal complications, such as massive bleeding, thrombosis and infection. This article hereby reported one case that left ventricular (LV) thrombosis occurred during ECMO and was successfully treated with anticoagulant alone without surgery.

Case presentation

A 28-year-old male (height 174cm, weighing 55kg) was admitted to the Emergency Intensive Care Unit (EICU) of our hospital on March 15, 2023 due to recurrent fever for 5 days. Electrocardiogram revealed V4-V6 ST segment elevation 0.05-0.2mv(Fig.1 panel A) and hyper-sensitive troponin T(hs-cTnT)was 5135ng/L. Six hours after admission, ventricular fibrillation occurred suddenly. Electric defibrillation was immediately applied, and chest compression was continued. He was diagnosed with fulminant myocarditis and cardiogenic shock and was connected to VA-ECMO immediately. The initial speed was 9200/min, the blood flow was 3.6L/min, the norepinephrine was 1.5ug/(kg/min) and heparin anticoagulation was 1u/(kg/h). Activated

clotting time [ACT] was monitored every 4 hours, activated partial thromboplastin time [APTT], prothrombin time [PT], and anti-Xa were monitored four times a day. On March 17, 2023, echocardiography showed that thrombosis in the patient's left ventricular (LV) (33*23mm in width, Fig.1 panel B, arrow). On March 20, 2023, the maximum diameter of the thrombosis was 47*12mm (Fig.1 panel C, arrow) and left ventricular ejection fraction (LVEF) (biplane Simpson method) was 54%.

Treatment

Because of poor cardiac function, the surgical procedure is not available. Thus, we strengthen anticoagulation treatment. Anticoagulant targets were adjusted to ACT>180s and APTT>60. Because of the high activity of antithrombin III, heparin anticoagulation was adjusted to 18u/(kg/h),In addition, the maximum APTT was 121.5s(Fig.1 panel E, arrow). On March 20, 2023. the patient met weaning criteria. We faced a dilemma at this point: the thrombosis in the heart is still there, if we wean him from ECMO, there is a high risk of cardiac arrest. If we do not wean him from ECMO, we need to maintain systemic anticoagulation therapy and the APTT is significantly prolonged. Under such circumstances, sustained ECMO may cause lethal hemorrhage. We carefully evaluated all the risk facing the patient and determined that the possibility of lethal hemorrhage is much higher than cardiac arrest so we decided to wean him from ECMO. Then the anticoagulant regimen was adjusted to enoxaparin 6000iu every 12 hours hypodermic inject. On March 21,2023, there was no obvious abnormal echo in the LV with color Doppler echocardiography (Fig.1 panel D, arrow), and combined with the patient data, thrombosis was diminished after anticoagulant therapy. On day 13, patient was weaned from mechanical ventilation and continuing to use enoxaparin 3000iu hypodermic inject every 12 hours. Subsequently, the patient gradually stabilized and was discharged on the 29th day of hospitalization with no central neurological damage, and no other organ system failures.

Conclusions and follow-up

Based on our case and literature analysis, left ventricular thrombosis is one of the most serious complications during ECMO. At present, the treatment of left ventricular thrombosis during ECMO mainly includes drug therapy, surgical thrombectomy, and left ventricular load unloading, but there are no specific guidelines about this. The volume of thrombosis in this case is the largest of all surviving cases reported so far of left ventricular thrombosis during ECMO receiving non-surgical treatment only (Table.1).

After 3 months of follow-up, the patient's cardiac ultrasound showed LVEF was 42% and the formation of a left ventricular posterior wall aneurysm. After 9 months of follow-up, the patient's cardiac ultrasound showed LVEF was 67% and the formation of a left ventricular posterior wall aneurysm. The patients had no special discomfort during the two follow-up visits.

Discussion

There were many complications during taking ECMO as a treatment, including: tearing of large vessels, massive bleeding (30%-70%) [1], and thrombosis. Left ventricular thrombosis is one of the rare but serious complications may lead to death. Many factors may cause thrombosis, and insufficient anticoagulation is one of them. Zhao et al. [2] suggested that the direct thrombin inhibitors (DTI), e.g., heparin, may prevent LV thrombosis. They suggest to use heparin to prolong the APTT to 50-60s. However, there is still no consensus on the target of heparin usage. In addition, researchers suggested to use ACT as monitoring marker to guide the anti-coagulate therapy, but the controversies are still existence [3-4].

There are very few case reports on ventricular thrombosis of ECMO. We reviewed previous case reports of left ventricular thrombosis during ECMO treatment. We used keywords "Left ventricular thrombosis" and "extracorporeal membrane oxygenation" and retrieved relevant literatures through PubMed (from 1993 to December 2023). We found only eight case reports and one review article [5-13]. In these reports (Table.1), five patients had survived, three patients had deceased. In one review article, the authors reported patients with heart thrombosis and all deceased. Among the 5 survived patients, the treatments were different, one patient [13] was treated by adjusting anticoagulant to Tenecteplase 30mg administration through a ventilation catheter. Three patients [5, 9, 10] were received surgical thrombectomy, and one patient [6] was

treated with a new technology -placed retrograde aortic root catheter for heparin infusion. To our knowledge, our patient is the only successful case that uses heparin/low molecular heparin to save the patient from LV thrombosis reported so far. In addition, the volume of thrombosis in our case is the largest of all reported survival cases by anticoagulation (Table.1).

In addition, anti-RO-52 antibody and anti-mitochondrial antibody M2 subtype of this patient were found positive in admission. However, there is no evidence in the literature which anyone can confidently use to causally link this antibody and thrombosis.

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Images and table

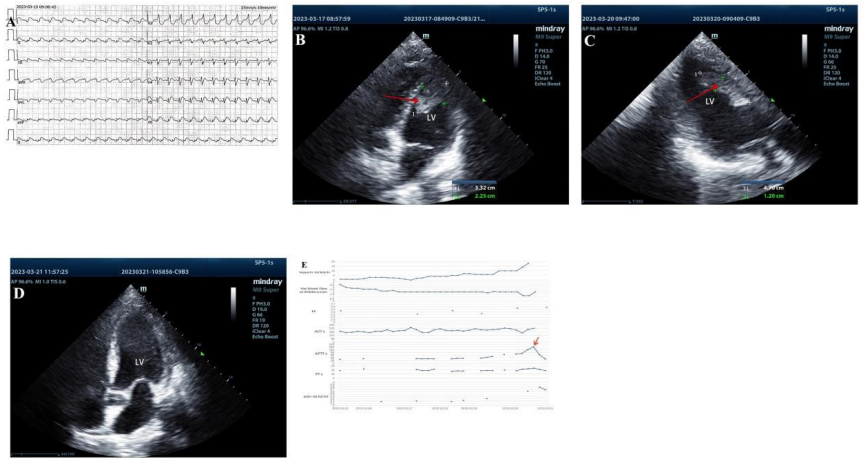

Fig .1. (A) Showing electrocardiogram on the first day of hospitalization. (B) Showing that the thrombosis was found by ultrasonography on March 17, 2023. (C) Showing that the maximum diameter of the thrombosis on March 20, 2023. (D) Showing that he left ventricular thrombosis was diminished on March 21, 2023. (E) Monitoring values of anticoagulant dosage, coagulation function, and partial correlation index during extracorporeal membrane oxygenation.

Table 1 Case reports of LV thrombosis during ECMO

Year	Author	Sex	Age	Cause	Thrombosis volume	Thrombosis location
2018	Huerter, M. et al.	F	33-year-old	Cardiac arrest	Not described	LV, the aorta and the supe
2020	Aljohani, O.A. et al.	M	15-year-old	Cardiogenic shock	About 1cm*0.75cm	Ending from the LV cavity
2017	Pořízka, M. et al.	M	73-year-old	Respiratory failure	2.6cm*7.5cm	LV
2013	Ramjee, V. et al.	M	57-year-old	Cardiogenic shock	About 3cm*3cm	LA, LV and proximal ascer
2017	Ogawa, M. et al.	F	57-year-old	Cardiogenic shock	500g	LA and LV
2014	Freud, L.R. et al.	F	5-week-old	Cardiogenic shock	About 2cm*0.5cm	LV and the aortic valve
2013	Kuhl, T. et al.	M	49-year-old	Cardiogenic shock	4cm*4cm*2.5cm	LV
2015	Sangalli, F. et al.	F	54-year-old	Myocardial infarction	About 3cm*1cm	LV

M: Male. F: Female. LA: Left atrium. LV: Left Ventricle.

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`Table.docx` available at https://authorea.com/users/818854/articles/1218322-successful-treatment-of-large-left-ventricular-thrombosis-during-extracorporeal-membrane-oxygenation-ecmo-a-case-report-and-review-of-the-literature