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CASE REPORT

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# Inserting a VA-ECMO cannula through an inferior vena cava filter during extracorporeal cardiopulmonary resuscitation

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**Abstract**

Venoarterial extracorporeal membrane oxygenation (VA-ECMO) has been utilized to treat massive pulmonary embolism (PE) accompanied by cardiac arrest or refractory cardiogenic shock. Our team opted for a femoral-femoral approach for vascular cannulation, using drainage and return cannulas in the common femoral vein and artery, respectively. However, femoral venous cannulation can be limited or challenging due to the presence of thrombus in the inferior vena cava (IVC), making the insertion of the drainage cannula via the femoral vein difficult. We present the case of a patient with massive PE who underwent aspiration thrombectomy and insertion of an IVC filter, followed by the initiation of VA-ECMO for cardiac arrest. We successfully inserted a femoral venous return ECMO cannula through the inferior vena cava filter during extracorporeal cardiopulmonary resuscitation. The patient stabilized with these interventions and ultimately achieved a favorable outcome with normal neurological status.

**Keywords** Case report, VA-ECMO, Inferior vena cava filter, Extracorporeal cardiopulmonary resuscitation, Pulmonary embolism

## Introduction

Acute pulmonary embolism (PE) is a significant cause of mortality worldwide. Most deaths resulting from acute pulmonary embolism (PE) occur within the first few hours to days, with over 70% of fatalities happening within the first hour. Massive PE accounts for approximately 4.5–10% of all PE cases and is associated with substantial morbidity and mortality, exceeding 50% [1]. Venoarterial extracorporeal membrane oxygenation (VA-ECMO) has been employed as a treatment option for patients with massive pulmonary embolism who are experiencing cardiac arrest or cardiogenic shock that is resistant to conventional therapies [1, 2]. However, there are only a limited number of reports on the insertion of ECMO cannulas through the femoral vein in patients who have inferior vena cava filters in place. We present the case of a patient with massive pulmonary embolism (PE) who underwent aspiration thrombectomy, followed by the placement of an inferior vena cava (IVC) filter, and subsequently required the initiation of venoarterial extracorporeal membrane oxygenation (VA-ECMO) due to cardiac arrest.

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## Presentation of case

A 42-year-old woman with body mass index of 29 kg/m$^2$ admitted at the emergency department presented with worsening shortness of breath for more than 1 h. She had undergone a fibroidectomy 10 days prior and received enoxaparin at a dosage of 0.4 ml/4000 IU bid for six days to treat postoperative deep venous thrombosis.On examination, her blood pressure was 110/70 mmHg, her heart rate was 148 beats/minute, her respiratory rate was 25 breaths/minute, and her oxygen saturation was 85% while she was breathing ambient air. Initial laboratory results showed elevated D-dimer (1595 ng/mL), level of antithrombin III (45%, normal range: 70-100%), and lactate (4.5 mmol/L) levels. Computed tomography pulmonary angiography (CTPA) revealed extensive pulmonary embolism involving the bilateral main pulmonary arteries and branches. The Pulmonary Embolism Severity Index (PESI) predicted a 10-24.5% risk of 30-day mortality.

The patient was transferred to the interventional center. Considering the surgical risks, our first choice was pulmonary artery thromboaspiration rather than pulmonary embolectomy. A large thrombus in the right pulmonary artery was successfully removed, but there was still residual thrombus in the left pulmonary artery. The inferior vena cava (IVC) filter was successfully deployed under fluoroscopy at the level of the L1-L2 vertebrae (Fig. 1). However, the patient's hypoxia worsened after the intervention. Oxygen saturation decreased to 81%, when the oxygen therapy was face mask at 10 L/min. Tracheal intubation and invasive mechanical ventilation were performed immediately. Five minutes later, she suffered a cardiac arrest and cardiopulmonary resuscitation (CPR) was immediately initiated. While CPR was being administered, the critical care team swiftly initiated VA-ECMO. A blind percutaneous femoral-femoral access technique was used, with a 21-Fr femoral venous cannula and a 17-Fr femoral arterial cannula. There was concern regarding cannulation due to her IVC filter. Placement was confirmed by abdominal X-ray. X-ray imaging revealed IVC filter migration with severe deformity (Fig. 2). The initial ECMO flow was 4 L/m$^2$/min. She was anticoagulated with heparin infusion during ECMO within the APTT targets (40–60 s). She improved clinically and was successfully weaned from ECMO on Day 7. During her stay in the ICU, she experienced respiratory failure complications, necessitating the need for a tracheostomy. On Day 15, she recovered and was discharged to another hospital for rehabilitation. The filter could

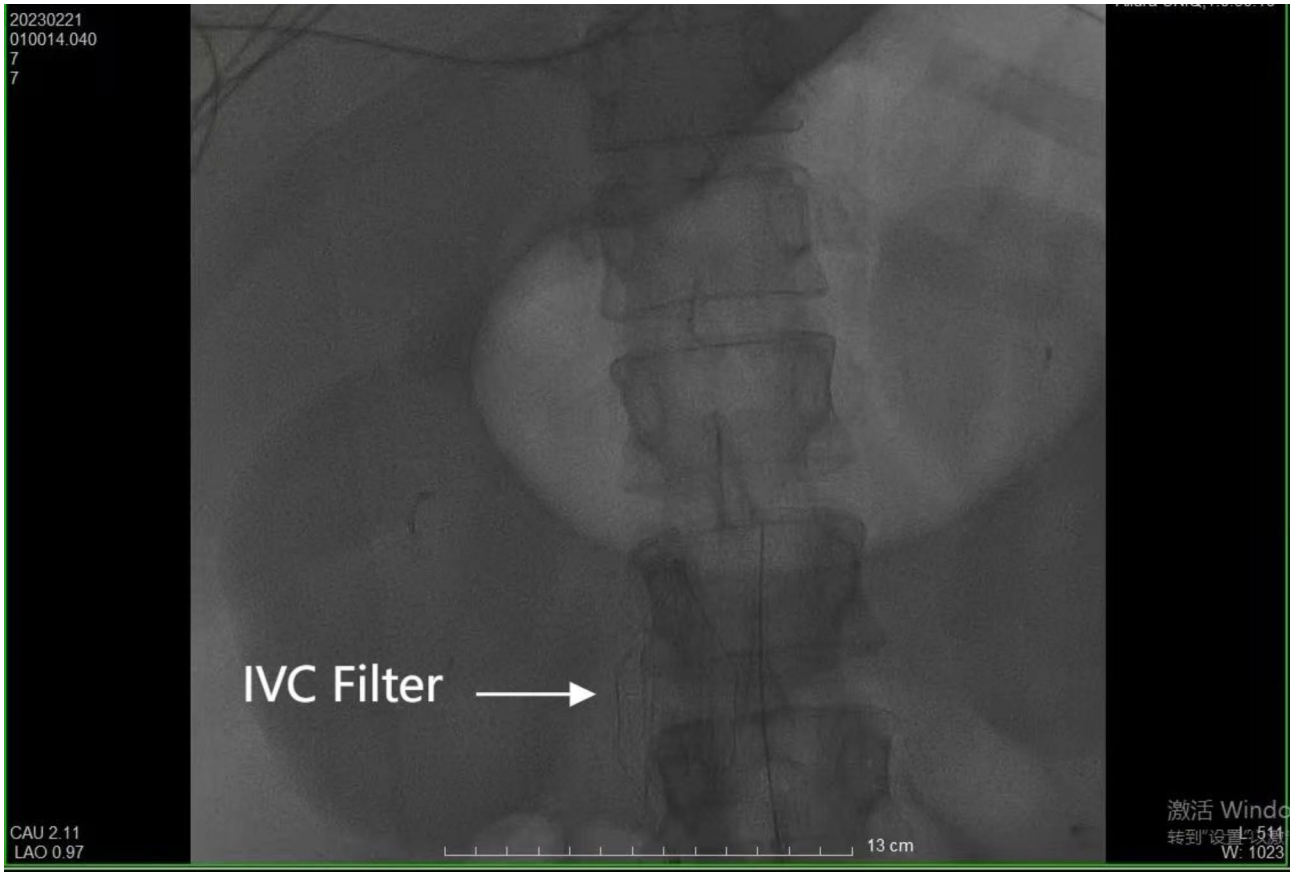


**Fig. 1** The IVC filter was deployed at the level of the L1-L2 vertebrae

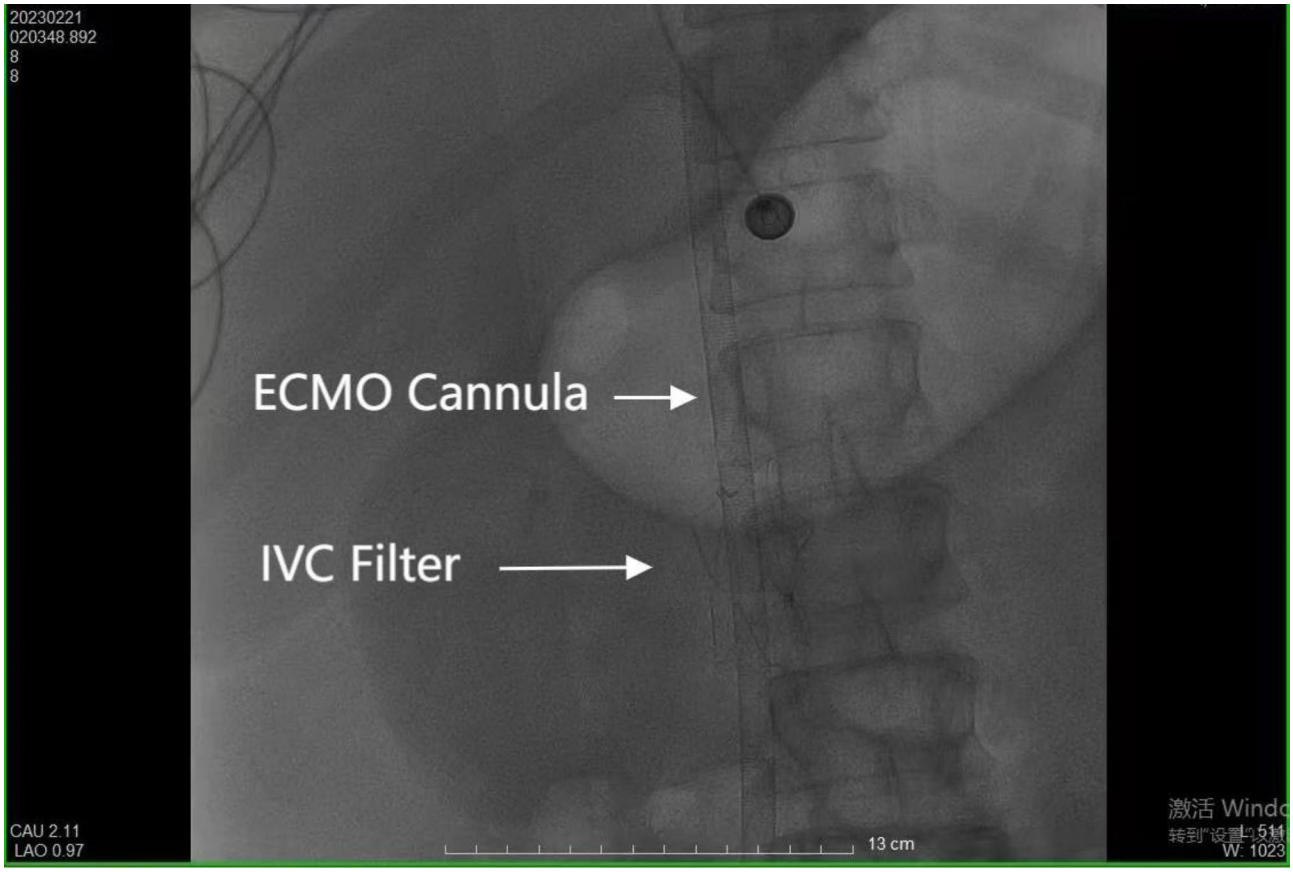


**Fig. 2** ECMO cannula traversed the IVC filter, and led to filter migration and deformity

not be retrieved, as it was deformed and firmly attached to the vascular wall (Fig. 3). Warfarin was used to prevent IVC filter thrombosis. At her 2-month follow-up appointment, the patient exhibited normal neurological function. Throughout the one-year follow-up period, follow-up visits were conducted every two months, which involved repeating blood routine tests, INR, D-dimer, and abdominal imaging examinations, including X-rays or CT scans. The patient exhibited good physical and functional recovery.

## Discussion

Pulmonary embolism is a common and potentially fatal cardiovascular disorder [3]. Previous studies have indicated that all-cause hospital mortality in patients with massive PE ranges from 44 to 65% [4, 5]. The mainstay of acute PE treatment is anticoagulation therapy. Patients with massive pulmonary embolism require advanced therapy for pulmonary artery reperfusion [6]. In cases of cardiac arrest or cardiogenic shock refractory to standard treatment, mechanical haemodynamic support, such as VA-ECMO, may be considered [7–9].

The femoro-femoral approach is favored for vascular cannulation when the drainage cannula is inserted through the femoral vein and advanced until its distal tip reaches a position 1–2 cm below the cavoatrial junction, followed by the preferred insertion of the return cannula into the femoral artery [7]. However, in patients with IVC filters, inserting drainage cannulas via the femoral vein may be difficult.

Ngoc Minh Le et al. presented a patient who had been diagnosed with COVID-19 and developed deep vein thrombosis [10]. An IVC filter was placed to prevent fatal pulmonary embolism. Her respiratory failure subsequently deteriorated, and she needed veno-venous extracorporeal membrane oxygenation (VV-ECMO) as a rescue therapy. Since the IVC filter impedes the femoral cannula, a double-lumen jugular cannula was inserted successfully. The report by Ngoc Minh Le provides us with some insights, when a patient with IVC filters is treated with VA-ECMO, inserting a jugular venous cannula, draining from the right atrium and infusing into the femoral artery is an option.

Dhaval Pau et al. reported the case of a pneumonia patient with severe respiratory failure requiring VV-ECMO. The patient had a previously placed inferior vena cava filter for unclear reasons. Under the guidance of transesophageal echocardiography and fluoroscopy,

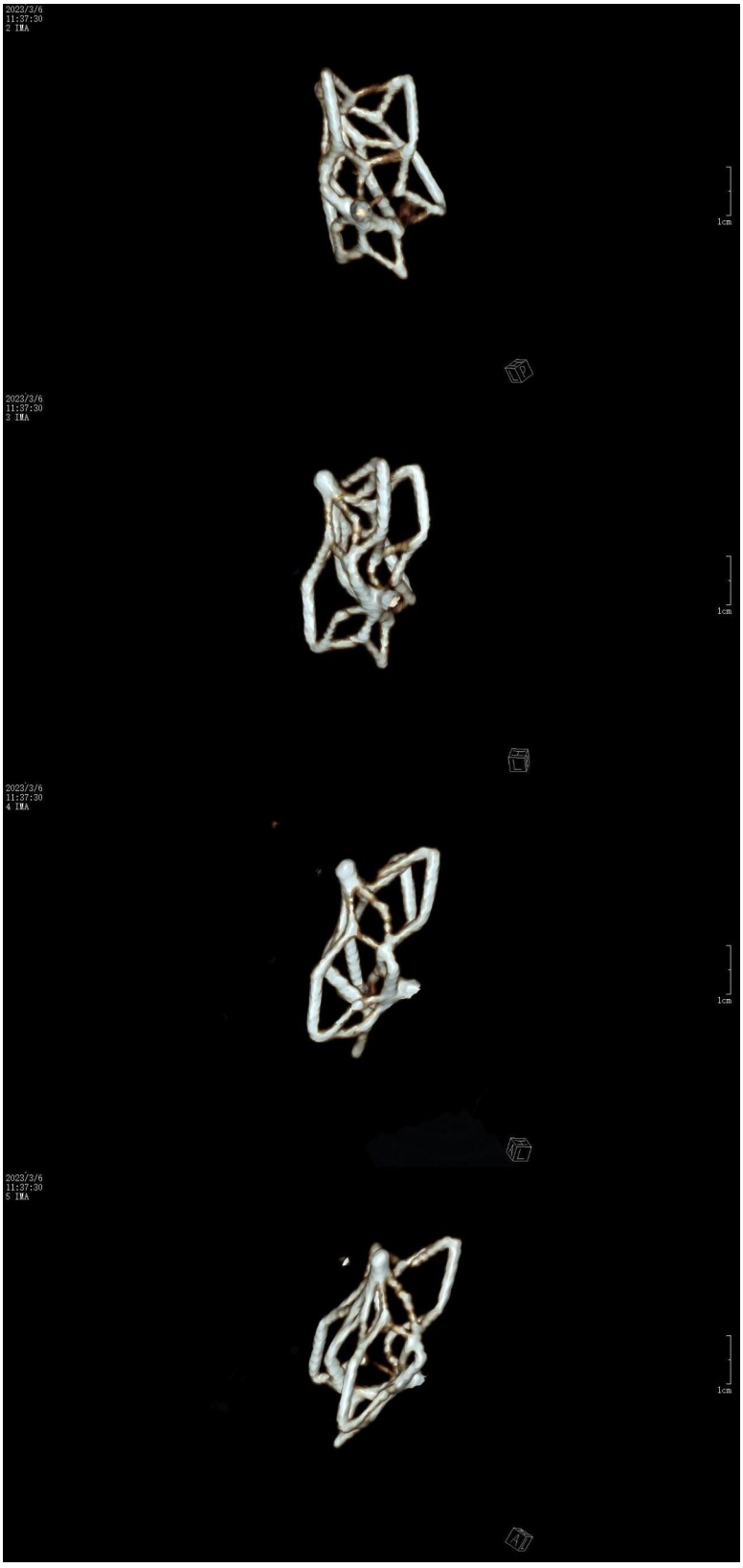


**Fig. 3** The 3D reconstructed image showed the deformed IVC filter in the IVC

jugular and femoral vein cannulas were inserted without dislodgement of the IVC filter [11]. Therefore, ultrasound or interventional guidance is a feasible way to help femoral vein cannulas pass through the IVC filter. In addition, the choice of a thinner venous drainage catheter may also increase the success rate of the catheter through the IVC filter. Dhaval Pau et al. suggested inserting a femoral vein cannula with the tip below the filter as another option [11]. However, this method might result in poor drainage and unstable and low ECMO flow.

To the best of our knowledge, this is the first case of femoral-femoral cannulation through an existing IVC filter during ECPR. Notably, percutaneous blind insertion of VA-ECMO cannulas through the IVC filter carries potential complications, such as filter migration, tilt and deformity. As mationed above, the better option and the less dangerous one might have been to insert the venous femoral canula below the IVC filter and to add a venous canula into the right atrium through the jugular venus vein to improve the venous drainage.

## Conclusion

In patients with IVC filters, inserting drainage cannula via femoral vein may be feasible, albeit it entails certain risks.

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**Author contributions**
GM, JX conceived and designed this study.RX collected the data. YW, and CP prepared the manuscript. All authors critically revised the manuscript and approved the final version.

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**Data availability**
No datasets were generated or analysed during the current study.

## Declarations

**Ethical approval**
This case report is approved by the Ethics Committee of Yancheng No.1 People's Hospital.

**Consent for publication**
The patient consented to the publishing of all images, clinical data, and other data included in the manuscript.

**Competing interests**
The authors declare no competing interests.

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