

# A homemade technique for removal a right atrial thrombus and review of the literature

Giulia Scopetani; Anna Nowacka; Matthias Kirsch\*

Department of Cardiovascular Surgery, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland.

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**\*Corresponding Author:** Matthias kirsch, Department of Cardiovascular Surgery, Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland.  
E-mail : [Matthias.kirsch@chuv.ch](mailto:Matthias.kirsch@chuv.ch).

## Abstract

**Background:** Blood clots could develop in cardiac cavities during extracorporeal membrane oxygenation (ECMO) despite achieving a perfectly balanced anticoagulation. Therapeutic strategies range from percutaneous thrombus aspiration to surgical intervention under cardiopulmonary bypass.

**Methods:** We report a case of a 24-year-old patient, born with complex congenital heart disease, admitted to our center for orthotopic heart transplantation. The complexity of the intervention and comorbidities necessitated the use of ECMO at the end of the transplantation. The rapid formation of a right atrium thrombus prompted us to search for a safe solution for our patient. We propose a safe method to remove a right atrial thrombus, in the presence of a frail patient in whom the use of cardiopulmonary bypass and percutaneous procedures were not acceptable.

**Results:** The procedure was performed without ECMO. The patient remained hemodynamically stable, and the aspirated blood was returned to the patient.

**Conclusion:** Despite achieving a perfect balance in anticoagulation, it is possible to discover a thrombus in the right heart cavity of ECMO patients. While various treatment options have been outlined, they should be tailored to the individual patient's needs. We believe that our homemade solution, when required by the patient's characteristics, is both safe and reproducible.

**Keywords:** Right atrial thrombus, ECMO, anticoagulation, Cell Saver.

## Introduction

Mechanical circulatory support (MCS) devices are complex and allow blood to bypass the heart or lungs (or both). When blood flows through these artificial devices, normal hemostasis is disrupted, coagulation is promoted, and in the absence of anticoagulants, a thrombus may develop in the device, resulting in device failure or embolic stroke. Therefore, anticoagulation is necessary to prevent blood clots and maintain device functionality. Titrating anticoagulation to prevent bleeding complications and thrombotic events can be difficult, and despite a perfect balance, a thrombosis can still occur [1,2]. Thrombosis is a potentially life-threatening complication in veno-arterial extracorporeal membrane oxygenation (VA-ECMO) circuits, which may originate from the drainage cannula due to unfavorable blood flow dynamics [3]. Cardiopulmonary collapse can come quickly with a massive pulmonary embolism.

## Case presentation

A 24-year-old patient was born with a complex congenital heart malformation consisting in type IIc tricuspid atresia, right ventricular hypoplasia, D-transposition of the great vessels, aortic arch hypoplasia, and a juxtaductal coarctation. Its condition led to Fontan circulation and secondary liver cirrhosis of cardiac origin, with portal hypertension and recent ligation of stage II esophageal varices. In addition, the patient presented with hereditary spherocytosis previously treated with splenectomy, a tracheomalacia, operated on at birth, and a severe esophageal reflux.

The patient was admitted to our center for the purpose of orthotopic heart transplant (OHT). The indication to use a VA-ECMO was due to a cardiopulmonary bypass lasting 392 minutes, and a right heart not prepared for the lack of elasticity of the pulmonary system, accustomed for years to a non-pulsatile flow. Moreover, a very difficult haemostasis, needing up to a dose of Novoseven, due to the basic coagulation disease.

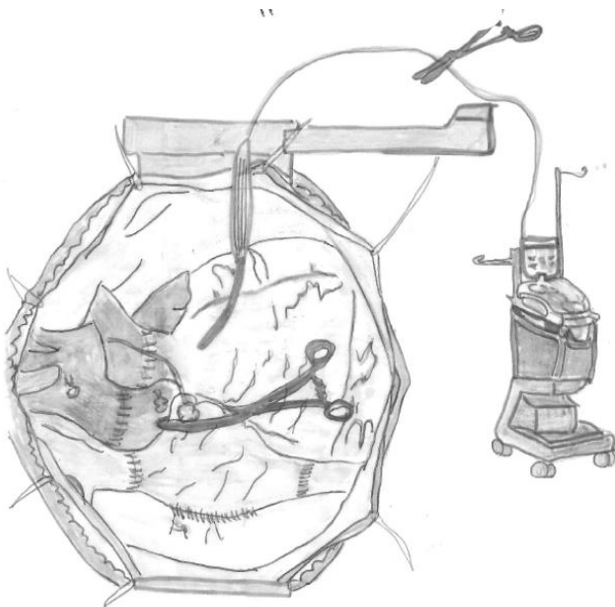
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On post-operative day 1 after OHT, a thrombus was discovered in the right atrium in contact with the femoral venous cannula (Image 1a and 1b). The patient was not anticoagulated due to perioperative and postoperative massive hemorrhagic shock, requiring hemostasis in the operating room every 2 days. We performed a post-operative chest scan without evidence of pulmonary embolism, without argument for major aortopulmonary collateral arteries (MAPCA). The impossibility of proceeding percutaneously, due to the recent cardiac sutures, and pulmonary hypertension, led us to wait the necessary time for ECMO weaning and proceed with the surgical removal of the thrombus. On post-operative day 6 after OHT, ECMO could be removed uneventfully. The procedure was as follows. A 5/0 Prolene suture was placed on the right auricle. A curved tangential clamp was used to close the right appendix and gave us time to aspirate the clot. The Cell Saver was used for this purpose with the unprotected metal vacuum cleaner at the

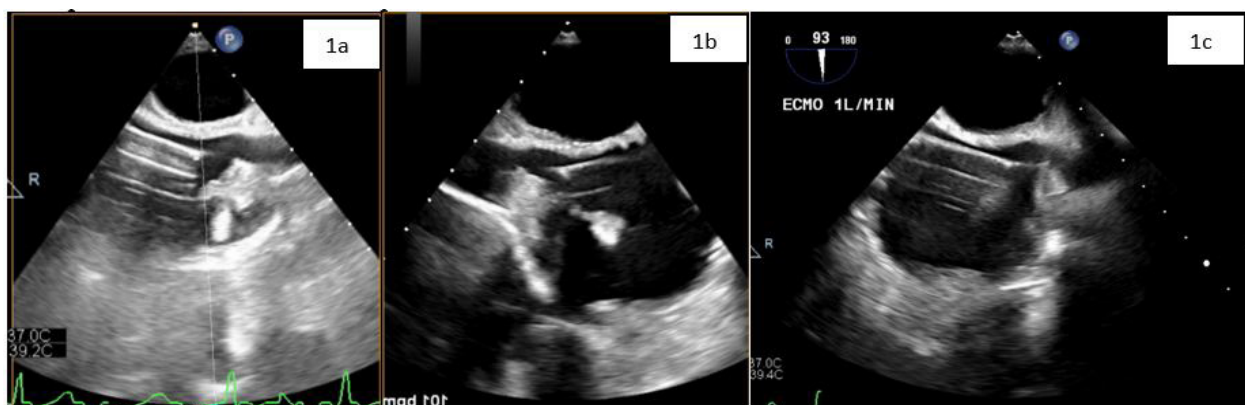
end. The Cell Saver vacuum was set at -100 mmHg. A clamp was placed on the Cell Saver's tubing to control the suction force (Figure 1). Two clots in size of 1 cm each were aspirated, together with 500 ml of blood which, after being processed, were given back to the patient, who remained hemodynamically stable during the procedure. The post procedural transesophageal echography (TEE) demonstrated an absence of residual thrombus (Image 1c).

## Discussion

The majority of intra cardiac thrombi occurred in cases which did not receive adequate anticoagulation, but this may not result in complete suppression of the coagulation response. Continued exposure to procoagulant stimuli and worsening ventricular function and intracardiac stasis can shift the balance toward a hypercoagulable state and development of thrombosis [2]. In this case we reported, the very difficult haemostasis associated with the use of Novoseven probably contributed to the formation of the thrombus. High-frequency ultrasound exposure near the clot's surface or percutaneous catheter-directed thrombolysis, endovascular mechanical thrombectomy using a capture device with fragmentation, as well as endovascular suction of the clot directly from the pulmonary arteries, ventricle, or atrium are just a few examples of approaches to intervention [4]. AngioVac is a venovenous filtration apparatus comprising drainage and reinfusion canulas, a centrifugal pump, and an extracorporeal filter [4, 5]. The device is inserted into the venous system through either the internal jugular vein or femoral vein, depending upon the location of the thrombus. Thrombi and/or vegetations are aspirated with the venous blood and extracted by the bypass pump filter and filtered blood is then returned to circulation through the outflow venous cannula. On the other hand, Bayona M et al. proposed that using FlowTrieve would be better than using AngioVac due to no need for extracorporeal perfusion [6]. Depending on the size of the clot, more invasive procedures may be required. Yang et al demonstrate a case report where they performed a surgical resection by lower mini-sternotomy due to the large size of the clot [7]. It's coupled with a full cardiopulmonary bypass [8]. For patients



**Figure 1:** A 5/0 Prolene suture placed on the right auricle. A curved tangential clamp to close the right appendix. The Cell Saver set at -100 mmHg with a clamp on the tube to control the suction force. The ECMO circuit runs in a loop and the canulas are in place in the femoral vessels.



**Image 1:** Bicaval view of transesophageal echography (TEE) before (1a and 1b) and after (1c) procedure.

who are hemodynamically unstable, it is a favored treatment option [9]. The frailty of our patient prevented us from using a percutaneous suction system, due to the risk of damaging the recent cardiac sutures. Conversion to cardiopulmonary bypass would have been hemodynamically safer for our patient but deleterious to coagulation control.

## Conclusion

Finding the right balance in the anticoagulation of patients in massive hemorrhagic shock, with a liver disease and with a mechanical circulatory support device is always a challenge. Despite a perfect balance in anticoagulation, right heart cavity thrombus could develop. Several therapeutic possibilities have been described, but these must be adapted to the patient conditions. Our strategy was safe and reproducible.

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