

Case Reports

RVAD Support in the Setting of Submassive Pulmonary Embolism

Antonio Salsano, MD;* Elena Sportelli, MD;* Guido Maria Olivieri, MD;* Nicola Di Lorenzo, MD;* Silvia Borile, MD;† Francesco Santini, MD*

*Divisions of Cardiac Surgery and †Cardiology, University of Genova Medical School, Genova, Italy

Abstract: Patients with submassive pulmonary embolism (PE), although normotensive, are characterized by right ventricular (RV) dysfunction and elevated levels of biomarkers of cardiac damage. The best treatment option in these cases is still a subject of debate and the use of thrombolysis in submassive PE remains controversial. A 57-year-old Caucasian male with unprovoked PE, normal blood pressure, and elevated troponin I values was referred to the cardiovascular department. In view of the presence of a right atrium thrombus, the patient underwent surgical embolectomy under extracorporeal circulation, with the extraction of

a huge thrombus together with fragmented thrombi from both pulmonary arteries. The patient developed an acute right heart failure solved with a temporary RV assist device (RVAD) support. The RV recovery was observed after 72 hours following the implantation. RVAD placement should be considered in the management of PE in case of acute right heart failure after reperfusion therapy since it can bring the patient out of a death spiral. **Keywords:** pulmonary embolism, cardiopulmonary bypass (CPB), circulatory assistance, temporary, echocardiography. *J Extra Corpor Technol. 2017;49:304–306*

Submassive or intermediate-risk pulmonary embolism (PE) identifies a subgroup of patients at increased risk for poor short-term outcomes (1). Although normotensive, they can be identified by the presence of right ventricular (RV) dysfunction detected on physical examination, electrocardiography, cardiac biomarkers, echocardiography, and chest computed tomography (CT). Fibrinolytic agent in addition to heparin and embolectomy are both possible treatment options, but the best treatment in these cases is still a subject of debate (1).

DESCRIPTION

A 57-year-old Caucasian male was referred to the cardiovascular department with unprovoked PE and symptoms of moderate dyspnea and a normal blood pressure. A contrast-enhanced-CT scan showed central filling defects within the

pulmonary arteries and a large thrombus in the right atrium (RA). A transoesophageal (TE)-echocardiography confirmed a worm-like mass in the RA (Figure 1A) with RV enlargement with associated hypokinesis and paradoxical septal systolic motion. Laboratory data show normal white blood cell and platelet counts, normal fibrinogen, slightly elevated D-dimer and troponin I values. The patient was under intravenous heparin anticoagulation therapy since 1st admission at the referring hospital. In view of the presence of a RA thrombus, the patient underwent surgical embolectomy under extracorporeal circulation, with the extraction of a huge RA thrombus (about 10 cm in length) together with fragmented thrombi from both pulmonary arteries (Figure 1B–1D).

After an initially uneventful postoperative course, about 24 hours since the procedure, the patient developed a severe acute RV failure with cardiogenic shock unresponsive to massive inotropic support and a Stockert Centrifugal Pump System equipped with Revolution centrifugal blood pump (LivaNova PNC, London, UK) as temporary RV assist device (RVAD) was implanted. Central cannulation with a 28 French (F) two-stage cavoatrial cannula and a 20 F outflow cannula into the pulmonary artery were applied. Cannulas were tunneled in the skin and secured with purse strings to reach the chest cavity and allow the

Received for publication February 13, 2017; accepted September 13, 2017. Address correspondence to: Antonio Salsano, MD, Division of Cardiac Surgery, University of Genova Medical School, Largo Rosanna Benzi 10, Genova 16132, Italy. E-mail: ant.salsano@gmail.com

The senior author has stated that the authors have reported no material, financial, or other relationship with any healthcare-related business or other entity whose products or services are discussed in this paper.

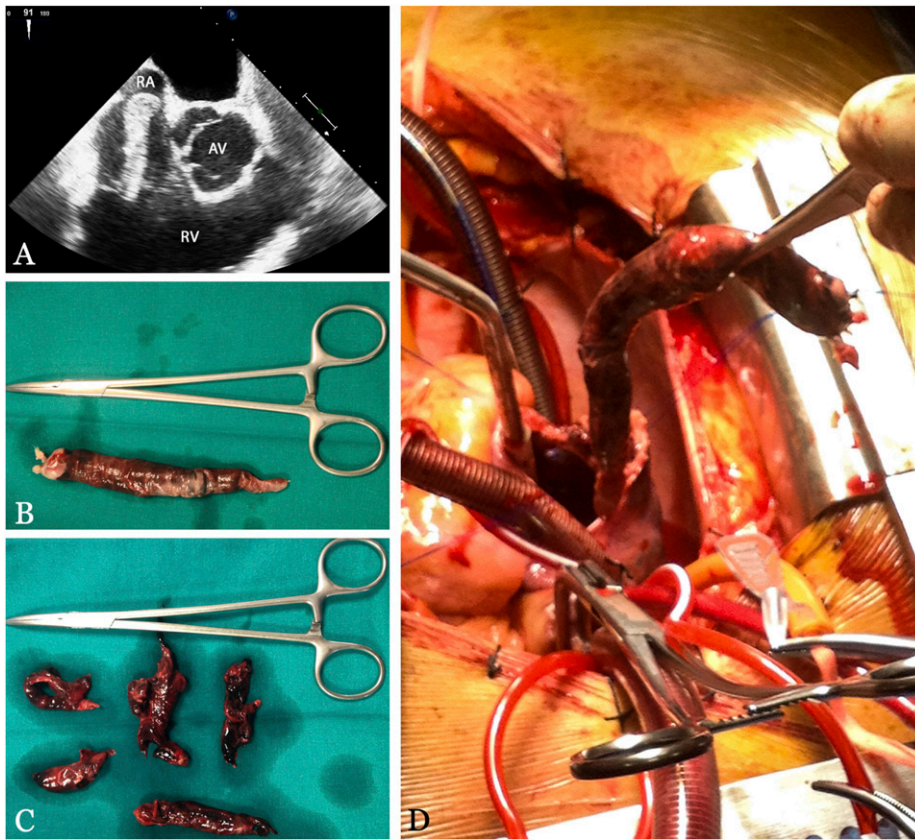


Figure 1. (A) TE-echocardiography [mid-esophageal right ventricle {RV} inflow–outflow view] showing a floating thrombus in the right atrium (RA) and dilated RV; AV = aortic valve; (B) Intraoperative view of thrombus removal from the RA; (C) Fragmented thrombi extracted from the pulmonary arteries; (D) Surgical specimen removed from the RA.

closure of the sternum in a standard fashion with steel wires.

To restore a systolic arterial pressure >100 mmHg, the pump flow was initially set at 4.5 L per minute and anticoagulation by continuous intravenous infusion of unfractionated heparin was adapted to reach values of activated clotting time >250 seconds. Right heart catheterization assessment showed a mean pulmonary arterial pressure (mPAP) of 47 mmHg and a pulmonary artery occlusion pressure (PAOP) of 23 mmHg.

A comprehensive evaluation of the RV dimension and function was carried out daily by TE-echocardiography. The recovery of the RV was observed after 72 hours with a tricuspid annular plane systolic excursion improvement from a value of 12 to 18 mm. RVAD flow was reduced to 3 L/min the 1st day after implantation, 2 L/min the 2nd day, and 1.4 L/min the 3rd day. After further 24 hours, the RVAD was discontinued because of the patient's stable hemodynamics with a pump flow <1 L/min. Moreover, mPAP and PAOP had been reduced to 32 and 13 mmHg, respectively, after weaning.

The genetic examination revealed a prothrombin gene mutation (G20210A) in heterozygosis. The patient was discharged in stable hemodynamic condition 1 month after

the operation under warfarin anticoagulation therapy and at 1-year follow up was alive and asymptomatic.

COMMENT

PE is a multifaceted disease, whose treatment and prognosis may change over time depending on the evolution of the anatomical and clinical picture.

For this purpose, several risk scores have been proposed to stratify the prognosis of patients with acute PE (2). The Pulmonary Embolism Severity Index, nowadays the most extensively validated score, quantify the 30-day prognosis from a very low ($<1.6\%$) to very high ($>10\%$) mortality risk (3).

Recent guidelines in addition to the assessment with the risk scores, suggest to carefully evaluate patients by focusing on the state of the right ventricle subjected to acute PE pressure overload (1,2).

In case of both RV dysfunction (by echocardiography or CT-scan) and elevated cardiac biomarker levels, patients should be identified as at risk of rapid deterioration. Therefore, a close hemodynamical monitoring is indicated to start promptly a reperfusion therapy if needed (2).

Right ventricle dysfunction is defined by qualitative echocardiographic criteria such as RV hypokinesia and quantitative criteria, like RV dilatation with an RV/left ventricular end-diastolic diameter >1 , RV end-diastolic diameter >30 mm, paradoxical septal systolic motion, pulmonary hypertension, and McConnell sign (RV free wall akinesia with sparing of RV apical motion) (4). TE-echocardiography is a useful tool for preoperative and intraoperative evaluation of RV function and localization of extrapulmonary thrombi (e.g., thrombus in the RA as in the present case) (5).

Data also suggest that the presence of right heart thrombi is a marker of worse prognosis in initially apparently stable patients (6). When thrombi are large in size or PE is central or paracentral, the surgical approach is a viable treatment option since the role of thrombolysis in submassive or intermediate risk PE remains controversial (7,8).

In our case, after the embolectomy, the patient developed a rapid and progressive RV failure probably caused by residual pulmonary hypertension due to microclot fragmentation with showering to distal arteries. With the use of the RVAD, the patient postoperative circulatory performance improved, mean systolic pressure increased and the cardiogenic shock was solved. The temporary circulatory support allowed the RV to adapt to pressure overload in a few hours and to be easily weaned. RVAD placement

should be considered in the management of PE in case of acute right heart failure after reperfusion therapy because it can bring the patient out of a death spiral.

REFERENCES

1. Jaff MR, McMurtry MS, Archer SL, et al. Management of massive and submassive pulmonary embolism, iliofemoral deep vein thrombosis, and chronic thromboembolic pulmonary hypertension. A scientific statement from the American Heart Association. *Circulation*. 2011;123:1788–830.
2. Konstantinides SV, Torbicki A, Agnelli G, et al. 2014 ESC guidelines on the diagnosis and management of acute pulmonary embolism. *Eur Heart J*. 2014;35:3033–69, 3069a–3069k.
3. Aujesky D, Obrosky DS, Stone RA, et al. Derivation and validation of a prognostic model for pulmonary embolism. *Am J Respir Crit Care Med*. 2005;172:1041–6.
4. Sekhri V, Mehta N, Rawat N, et al. Management of massive and nonmassive pulmonary embolism. *Arch Med Sci*. 2012;8:957–69.
5. Pruszczyk P, Torbicki A, Kuch-Wocial A, et al. Diagnostic value of transoesophageal echocardiography in suspected haemodynamically significant pulmonary embolism. *Heart*. 2001;85:628–34.
6. Torbicki A, Nazzareno G, Covezzoli A, et al; on behalf of the ICOPER Study Group. Right heart thrombi in pulmonary embolism. Results from the international cooperative pulmonary embolism registry. *J Am Coll Cardiol*. 2003;41:2245–51.
7. Xu Q, Huang K, Zhai Z, et al. Initial thrombolysis treatment compared with anticoagulation for acute intermediate-risk pulmonary embolism: a meta-analysis. *J Thorac Dis*. 2015;7:810–21.
8. Leacche M, Unic D, Goldhaber SZ, et al. Modern surgical treatment of massive pulmonary embolism: results in 47 consecutive patients after rapid diagnosis and aggressive surgical approach. *J Thorac Cardiovasc Surg*. 2005;129:1018–23.