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Case Report

Catastrophic Cardiac Arrest Caused by Acute Pulmonary Hypertension After Removal of Giant Left Atrial Thrombus

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Abstract

Background: Pulmonary hypertension (PH) is defined as a resting mean pulmonary arterial pressure (mPAP) >20 mmHg on right heart catheterization, as described in the proceedings of the 6th World Symposium on Pulmonary Hypertension. Left-sided heart failure (left heart disease) is the most common cause of pulmonary hypertension (PH). Transesophageal echocardiography (TEE) plays an important role in the monitoring of PH. But the disadvantage of TEE is the lack of continuity of monitoring. For patients with severe mitral stenosis and severe PH, should the Swan-Ganz catheter be placed routinely? The monitoring of pulmonary artery pressure and pulmonary venous pressure by Swan-Ganz catheter can guide the management of perioperative circulation and respiration, especially for early detection of PH. *Case presentation*: This case report introduce a severe mitral valve stenosis with giant left atrium thrombosis performing cardiac surgery. After the removal of giant left atrial mass and mitral valve replacement under cardiopulmonary bypass (CPB), the patient gradually experienced difficulty in ventilation and persistent refractory hypotension, followed by ventricular fibrillation during the process of chest closure. *Conclusions*: TEE helps diagnose acute pulmonary hypertension. Although TEE plays an important role in the diagnosis and the decision to use mechanical devices, a Swan-Ganz catheter would be an effective hemodynamic monitoring device and can be used in conjunction with TEE in cardiac surgery.

Keywords

Mitral Valve Stenosis, Giant Left Atrial Thrombus, Pulmonary Hypertension

1. Introduction

Mitral stenosis is associated in up to 17% with atrial thrombus. [1] The changed anatomy and enlarged volume of the left atrium, abnormal blood flow into the atrium, abnormal atrial contraction, decreased mitral valve area (MVA), and impaired endothelial function are the key determinants of increased risk of thrombus formation in these patients. [2]

Pulmonary hypertension (PH) is defined as a resting mean pulmonary arterial pressure (mPAP) >20 mmHg on right heart catheterization. Left-sided heart failure (left heart disease) is the most common cause of PH. [3, 4] PH is common in symptomatic mitral stenosis. Mechanical factors, vascular remodeling, and endothelial changes mediate it, and neuro-hormones may influence the course of the disease. Transesophageal echocardiography (TEE) plays an important

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role in the monitoring of Pulmonary hypertension (PH). [5] We introduce a patient who underwent mitral valve replacement and thrombectomy, including tricuspid valve annuloplasty. During the process of chest closure, the patient gradually experienced difficulty in ventilation and persistent refractory hypotension, followed by ventricular fibrillation. Veno-arterial extracorporeal membrane oxygenation (VA-ECMO) treatment is performed for patients with PH that is difficult to correct.

2. Case History

A 53-year-old female patient was admitted to the hospital due to a history of progressive shortness of breath, progressive dyspnea, and more than 30 years. Two months before admission her activity became limited due to increasing shortness of breath, repeated coughing, and recurrent paroxysmal nocturnal dyspnea. The patient did not receive warfarin anticoagulation therapy and did not have any comorbidities.

Transthoracic echocardiography showed atrial fibrillation with enlarged atrial. Evidence of mitral restenosis (MVA 0.8 cm^2) was seen. The tricuspid valve was moderately incompetent with an estimated pulmonary artery systolic pressure (PASP) of 75 mmHg. Intraoperative real-time transthoracic echocardiography (TTE) confirmed mitral stenosis and revealed an expanded and homogenous mass in the left atrium with an extent of 8.5 cm*9 cm (Figure 1). Additional computed tomography (CT) showed this mass filling the lateral and superior wall of the left atrium with an extent of 9cm*13cm. Intraoperative TEE confirmed a giant mass in the left atrium (Figure 2) and detected mobile parts with abundant smoke in the left atrium. In conclusion, the left atrial mass could be identified as a giant thrombus. Laboratory investigations revealed a low hemoglobin level (11.2 g/dL) and low platelet count with mild hypoproteinemia.

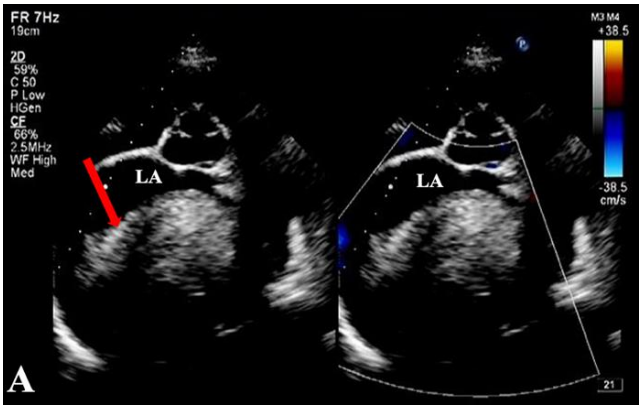

Figure 1. *Giant Left Atrial Thrombus (TTE).*

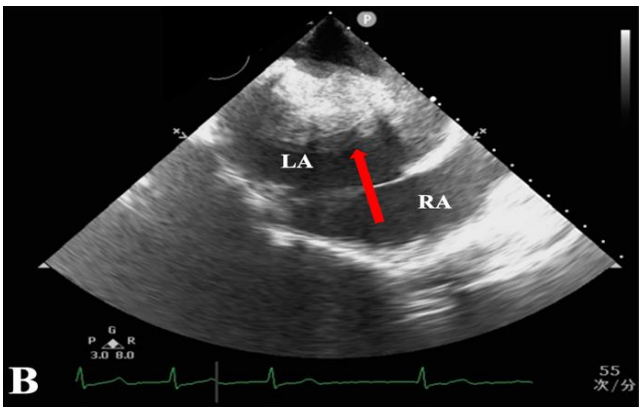

Figure 2. *Giant Left Atrial Thrombus (TEE).*

Surgery was performed using standard CPB with moderate hypothermia and antegrade blood cardioplegia. A giant thrombus was difficult to remove because the adhesion between the thrombus and the left atrium was very serious. Therefore, the thrombus is chopped up and taken out carefully. The mitral valve was replaced with St. Jude Medical valve. The tricuspid valve was repaired using Devag's annuloplasty. Minimal inotropic support was used during weaning from bypass.

Gradually hypotension combined with poor ventilation during the process of chest closure. Even after an intravenous injection of 1 mg of hydroxylamine, systolic blood pressure dropped from 110 mmHg to 60 mmHg, followed by an intravenous injection of epinephrine 0.3 mg, and the patient's arterial blood pressure continued to decline and he developed ventricular fibrillation. Immediately perform chest heart compression and open the chest to prepare for CPB again. At the same time, she was given electric defibrillation 200J, intravenous epinephrine 1mg. Fifteen minutes later, CPB was re-established through the original position of the aortic cannula and superior and inferior vena cava cannula, and the patient returned to sinus rhythm with full CPB support. TEE monitors that the artificial valve function is normal and the left ventricular systolic function is normal. PASP was measured directly at 90 mmHg using a 10 ml syringe needle connected to a transducer to puncture the pulmonary artery. After improving the internal environment and adjusting the ventilation and vasoactive drug dosage, the PASP dropped to 72mmHg. Then try to wean from CPB again smoothly guided by TEE. But during the separation of the second time, it was found that the PASP rose rapidly from 72 to 122mmHg. TEE monitoring through the left ventricular short-axis view revealed a "D" sign during systole (Figure 3). The view of the right ventricular inflow and outflow view showed that the pulmonary artery was dilated (Figure 4). The attempt at separation from CPB failed. Considering the difficulty of separating from CPB, our team decided to establish VA-ECMO using femoral artery and femoral vein catheterization. Unfortunately, the patient died of multiple organ failure on the third day after surgery.

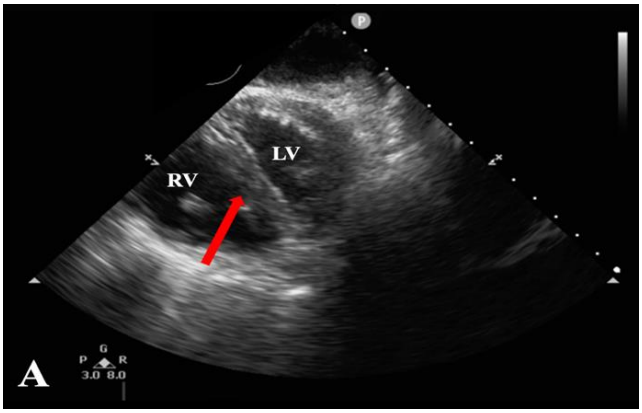

Figure 3. *"D" sign.*

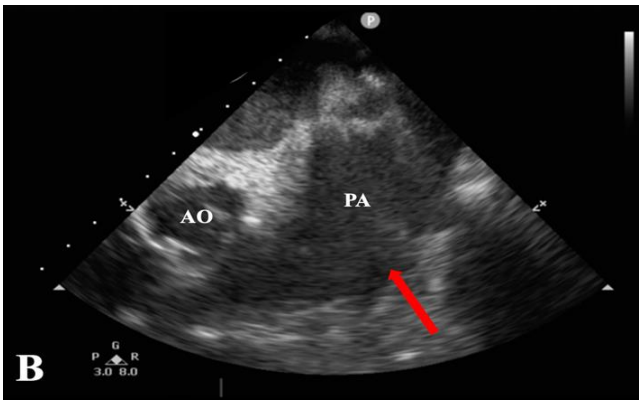

Figure 4. *The pulmonary artery.*

3. Discussion

A significant reduction was witnessed in the prevalence, incidence, and associated fatalities of rheumatic heart disease (RHD) in high-income countries in the late 20th century. [6] At present, the patients with mitral valve stenosis in our center are still dominated by rheumatic diseases. Mitral stenosis remains an important cause of morbidity despite the ease with which it can be diagnosed and treated. The onset of atrial fibrillation, which is often caused by atrial inflammation and remodeling, is a pivotal moment in mitral stenosis. Atrial fibrillation occurs in 40–75% of patients who are symptomatic for mitral stenosis, precipitates such symptoms, greatly increases the risk of systemic embolization, and reduces cardiac output and exercise capacity. [7, 8] If the left atrial appendage thrombosis and there is no regular anticoagulation treatment, the embolus is very likely to cause cerebral infarction or other organ embolism.

Long-standing mitral valve disease is associated with enlargement of the left atrium as a compensatory mechanism due to increasing intracavitary pressure and volume. Such an enlargement is beneficial as it reduces pulmonary congestion, thus it protects the lung from PH and edema. [9] However, with the gradual increase in left atrial pressure an associated increase in pulmonary venous pressure will eventually occur. [10] As the course of the disease progresses and pressure conducts, pulmonary arteries develop vascular endothelial dysfunction and appear reactive vasoconstriction, neuroendocrine and inflammatory cell activation, NO reduction, increased endothelin secretion, and decreased vasodilation effect of brain natriuretic peptide (BNP), and other pathophysiological changes that promote pulmonary vascular remodeling. The structure, leading to the occurrence of PH, further restricts the ability of the right ventricle to transfer blood to the pulmonary artery, causing right heart overload and right heart failure. At the same time, the left ventricular filling will be damaged again through ventricular interdependence. [11]

Pulmonary hypertension associated with left heart disease (PH-LHD) can be classified into two main subtypes: isolated postcapillary PH (IpcPH) and combined post and precapillary PH (CpcPH). [12] When pulmonary vascular resistance (PVR) is <3 Wood units, PH is considered to be IpcPH, reflecting elevated left atrial pressure without intrinsic pulmonary vasculopathy. If the PVR is≥3 Wood units, the elevated left atrial pressure is considered to be CpcPH which means that irreversible damage has occurred to the pulmonary vessels. Although the pulmonary capillary wedge pressure (PCWP) has been reduced to a certain extent after mitral valve replacement in this patient, the PVR has not been greatly reduced because of the pathological changes in the pulmonary vessel itself. During the process of chest closure, it can cause an increasing in chest pressure, further increasing pulmonary artery pressure and PVR. This leads to an increase in right ventricular pressure. The increase in right ventricular pressure squeezes the left ventricle, further reducing the filling of the left ventricle. Meanwhile, PH can also increase the shunt in the lungs and reduce the patient's oxygenation. Therefore, the patient has circulatory instability and poor ventilation, which eventually causes circulatory shock and ventricular fibrillation.

TEE plays an important role in the monitoring of PH. But the disadvantage of TEE is the lack of continuity of monitoring. For patients with severe mitral stenosis and severe PH, should the Swan-Ganz catheter be placed routinely? The monitoring of pulmonary artery pressure and pulmonary venous pressure by Swan-Ganz catheter can guide the management of perioperative circulation and respiration, especially for early detection of PH. Few case reports describe percutaneous Swan-Ganz catheter removal, in which both chordae and papillary muscle ruptures have been observed. [13, 14] A Swan-Ganz catheter remains an effective hemodynamic monitoring device and can be used in conjunction with TEE, in cardiac surgery. [15]

4. Conclusion

In conclusion, we introduce a case of severe mitral valve stenosis with giant left atrium thrombosis performing cardiac surgery. The patient gradually experienced difficulty in ventilation and persistent refractory hypotension, followed by ventricular fibrillation during the process of chest closure.

TEE plays an important role in the diagnosis of PH and the decision to use mechanical devices. A Swan-Ganz catheter would be an effective hemodynamic monitoring device and can be used in conjunction with TEE in cardiac surgery.

Abbreviations

CPB	Cardiopulmonary Bypass
TEE	Transesophageal Echocardiography
MVA	Mitral Valve Area
PH	Pulmonary Hypertension
VA-ECMO	Veno-arterial Extracorporeal Membrane Oxygenation
TTE	Transthoracic Echocardiography
CT	Computed Tomography
RHD	Rheumatic Heart Disease
BNP	Brain Natriuretic Peptide
PH-LHD	Pulmonary Hypertension Associated with Left Heart Disease
IpcPH	Isolated Postcapillary Pulmonary Hypertension
CpcPH	Combined Post and Precapillary Pulmonary Hypertension
PVR	Pulmonary Vascular Resistance
PCWP	Pulmonary Capillary Wedge Pressure

Author Contributions

Meng Dai: Data curation, Formal Analysis, Writing – original draft

Zhuling Fan: Data curation

Xuejie Li: Methodology, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflict of interest.

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