

Massive pulmonary embolism and thrombus-in-transit via a patent foramen ovale: a case report of successful use of extracorporeal membrane oxygenation to manage post-embolectomy severe right ventricular dysfunction

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Background

Pulmonary embolism with thrombus-in-transit through a patent foramen ovale is rare. It may present with neurological sequelae and rapid diagnosis is needed to prevent mortality and morbidity. The European Society of Cardiology (ESC) published guidelines in 2019 for diagnosis and management of acute pulmonary embolism which were useful in this case.

Case summary

A 32-year-old sedentary male presented with sudden onset shortness of breath, syncope, a probable seizure, and chest pain. Investigations showed an acute pulmonary embolism with mobile thrombus in the right atrium and right ventricle and also thrombus-in-transit passing through a patent foramen ovale into the left atrium. He was resuscitated and rapidly transferred to theatre where he underwent surgical thromboembolectomy. There was difficulty in separating him from cardiopulmonary bypass due to right ventricular failure and he was initiated on extracorporeal membrane oxygenator support. He recovered fully and was discharged home after 43 days.

Discussion

This case report highlights the presentation of this rare diagnosis and discusses the management of acute pulmonary embolism according to recent ESC guidelines.

Keywords

Pulmonary embolism • Pulmonary thromboembolectomy • Right ventricular failure • ECMO • Case report

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Learning points

- A high index of suspicion is needed to detect pulmonary embolism in a young patient.
- Thrombus in transit through a patent foramen ovale is rare and early diagnosis is vital.
- Expedited surgical management may still be complicated with severe right ventricular dysfunction requiring mechanical circulatory support.

Introduction

Pulmonary embolism (PE) presenting with a thrombus-in-transit via a patent foramen ovale (PFO) is rare and demands a high index of suspicion and early surgical management because of the high risk of systemic embolization and mortality.¹ Expedited surgical management can get complicated by severe right ventricular (RV) dysfunction where the role of extracorporeal membrane oxygenation (ECMO) proves crucial.² We report a case of massive PE with thrombus-in-transit, which had a complicated intraoperative and post-operative course despite ECMO support.

Timeline

Day 0	Patient presented with an episode of sudden onset shortness of breath followed by syncope and suspected seizure activity Echo and computerized tomography pulmonary angiogram (CTPA) confirmed a pulmonary embolism with thrombus passing to the left atrium through a patent foramen ovale Emergency pulmonary embolectomy was performed complicated by the difficulty in separating from cardiopulmonary bypass due to severe right ventricular failure The patient required full extracorporeal membrane oxygenation (ECMO) support
Day 6	Weaning off ECMO and closure of the open chest
Day 8	Sepsis
Day 20	Tracheostomy
Day 37	Decannulation of tracheostomy
Day 43	Discharged home
Week 6	Follow-up shows the complete recovery of functional status and normalization of ventricular function

Case presentation

A 32-year-old male presented with sudden onset shortness of breath, syncope, and a seizure and chest pain of several hours' duration. He had had flu-like symptoms a few days previously. He had an intellectual disability owing to developmental delay which led him to

a sedentary house-bound lifestyle. His only comorbidity was previously diagnosed hypertension, but he was not taking any medications at the time of presentation.

The patient was tachycardiac with a heart rate of 110 b.p.m., hypotensive (90/52 mmHg), and hypoxic on presentation with oxygen saturation of 92% on room air. Chest auscultation was clear. Heart sounds were normal.

Electrocardiogram showed T wave inversions in leads II, III, and aVF suggestive of right ventricular (RV) strain (Figure 1). Transthoracic echocardiography showed dilated RV with mobile thrombus in the right atrium (RA) and RV which was also passing through the PFO into the left atrium (LA).

His urea and creatinine were mildly elevated [urea 10.6 mmol/L (2.76–8.07 mmol/L) creatinine 144 µmol/L (62–106 µmol/L)], his haemoglobin was high but within normal limits at 168 g/L (130–180 g/L), his haematocrit was high at 55.9% (40–50%) all suggesting a picture of dehydration.

His lactate was high but within normal limits at 2 mmol/L (0.6–2.2 mmol/L) and also his D-Dimer was elevated 3.84 µg/mL (0–0.5 µg/mL). His troponin was elevated at 2.28 µg/L (0–0.3 µg/L).

The patient was resuscitated as per European Society of Cardiology (ESC) guidelines.³ Due to haemodynamic instability and the presence of a thrombus-in-transit the patient was transferred urgently to theatre for emergency pulmonary embolectomy (Class IIa ESC recommendation). Prebypass transoesophageal echocardiography confirmed the findings of extensive clot in RA, RV, and passing through the PFO to the LA (Figure 2). There were classical findings of a D-shaped septum pushed towards the left ventricular (Figure 3). Fresh clots were noted in the pulmonary tree, RA, LA, and RV (Figure 4). The tricuspid valve had severe regurgitation. All clots were removed, the PFO was closed by Bovine pericardial patch and a tricuspid valve annuloplasty was performed. Epinephrine infusion was commenced however severe right ventricular dysfunction persisted and caused difficulty in separating from cardiopulmonary bypass (CPB). Hence, central ECMO was initiated, and the patient weaned off CPB and moved to the intensive care unit (ICU).

Initially, the patient remained in a critical state on ICU with full ECMO support. He was commenced on early renal support (continuous venovenous haemodiafiltration) and continued on the epinephrine infusion. His ventricular function was monitored with daily echocardiograms and his RV function was initially severely impaired but improving every day. He was commenced on intravenous (IV) sildenafil for pulmonary vasodilation. After 6 days, the RV had improved and the patient was weaned off ECMO. He remained critical in ICU for some time, complicated by sepsis, acute kidney injury, and critical illness neuropathy. Aggressive supportive care continued. His respiratory function stabilized and a percutaneous tracheostomy was

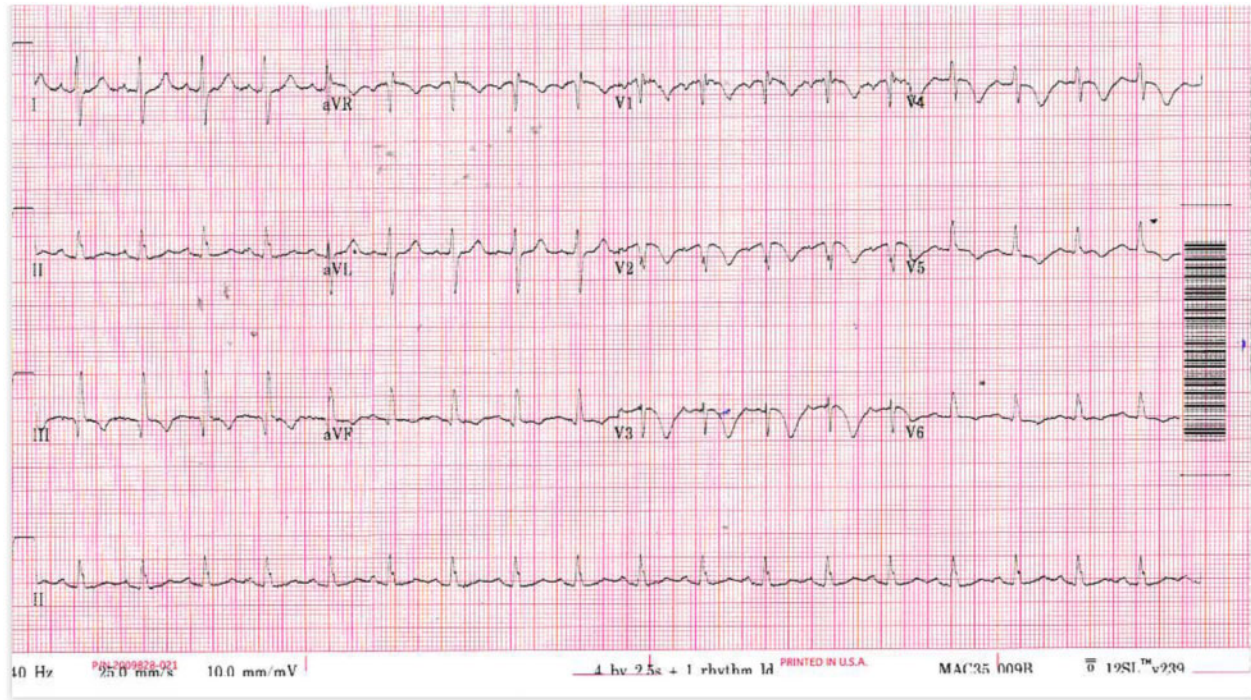


Figure 1 Electrocardiogram showing characteristic S1 Q3 T3 pattern.

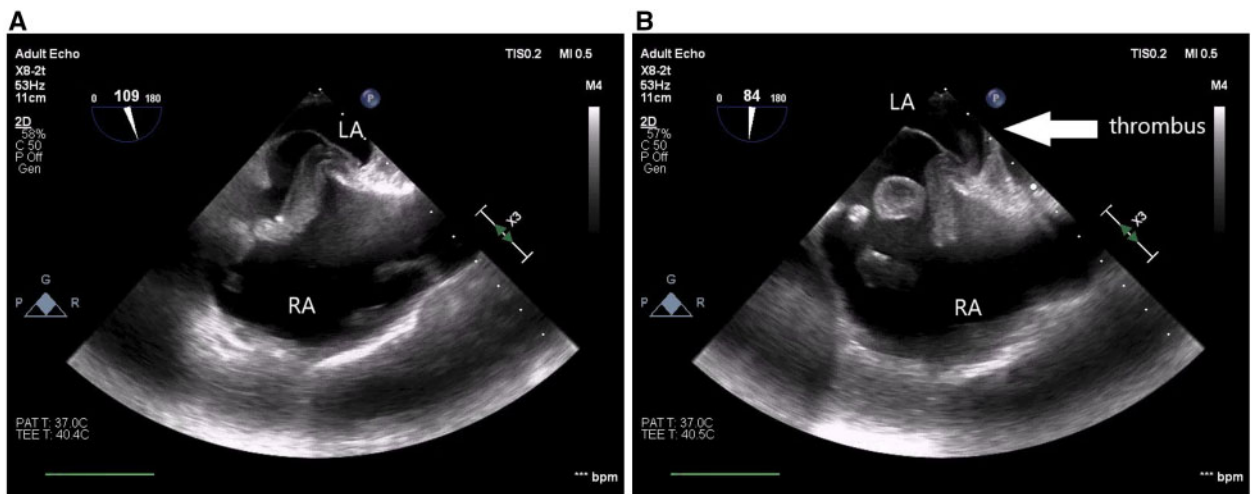


Figure 2 Images showing clot in right atrium and in transit through patent foramen ovale.

performed on post-operative Day 20. He was successfully weaned from the ventilator on post-operative Day 28.

He was initially fully anti-coagulated on IV heparin, when he became more stable, he was converted to warfarin which is to be continued for life. The IV sildenafil was converted to oral tildenafil which was continued for 3 months. His recovery was further complicated by an episode of haematemesis and endoscopy revealed an old traumatic ulcer which was clipped.

After this, he rapidly improved. His tracheostomy tube was removed on Day 37, and he was discharged home 43 days post-operatively.

During his admission, he was reviewed by pulmonology, haematology, and rheumatology teams to investigate underlying causes of prothrombosis. Antinuclear antibodies, factor V Leiden mutation, anticardiolipin, double-stranded DNA antibodies, and beta-2 glycoprotein-1 antibodies were all negative. There was no evidence to

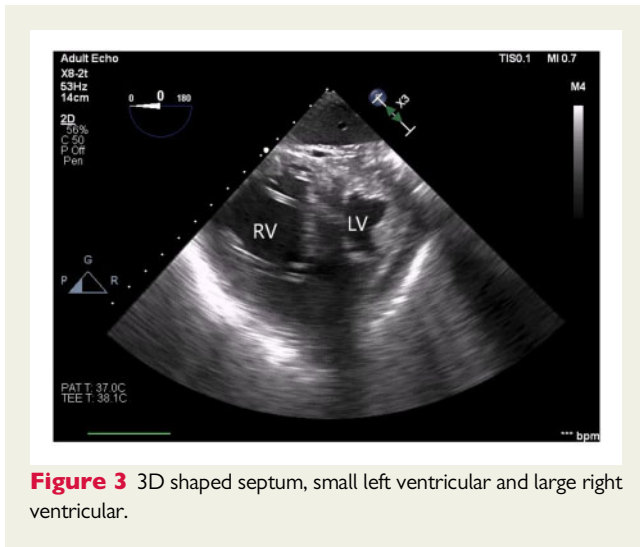
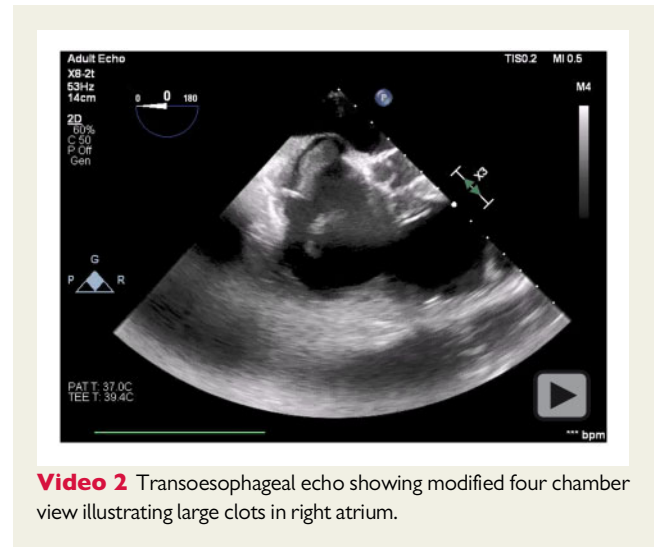


Figure 3 3D shaped septum, small left ventricular and large right ventricular.



Video 2 Transoesophageal echo showing modified four chamber view illustrating large clots in right atrium.

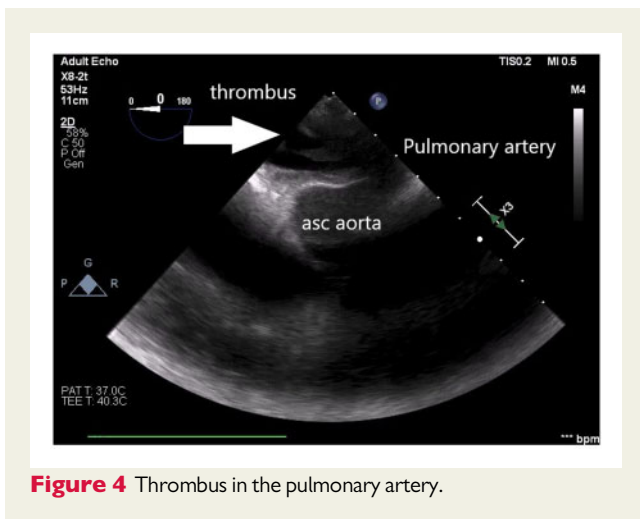
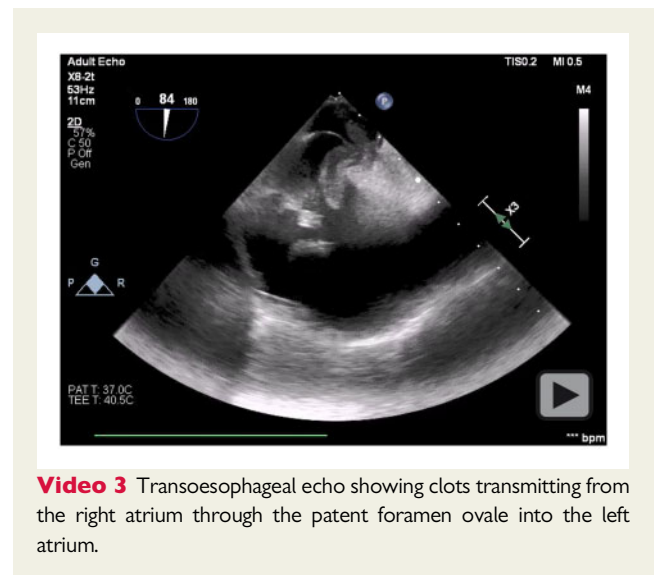
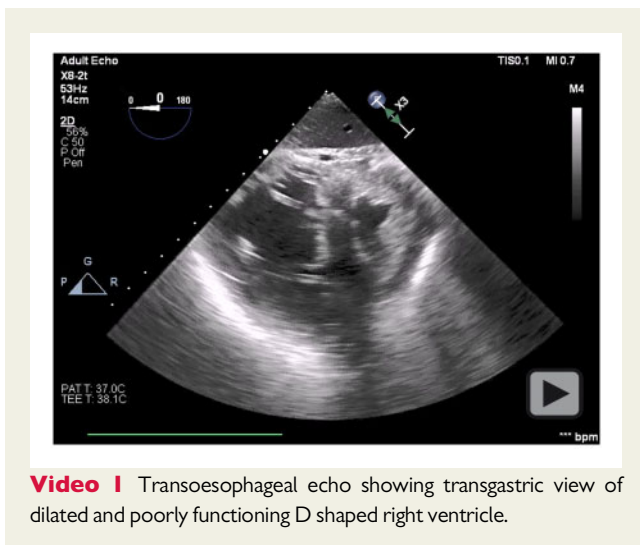


Figure 4 Thrombus in the pulmonary artery.



Video 3 Transoesophageal echo showing clots transmitting from the right atrium through the patent foramen ovale into the left atrium.



Video 1 Transoesophageal echo showing transgastric view of dilated and poorly functioning D shaped right ventricle.

suggest Bechet's disease. No evidence of underlying malignancy could be found in this patient, investigations included chest computerized tomography scan (CT) and cytology from bronchoscopy.

A follow-up outpatient echo 6 weeks after discharge showed complete normalization of RV function and the patient is fully recovered and back to everyday activities.

Discussion

Venous thromboembolism, clinically presenting as deep venous thrombosis or PE, is globally the third most frequent acute cardiovascular syndrome behind myocardial infarction and stroke.

Although there was no evidence of acute ischaemia on the brain CT of this patient, he presented with a seizure and syncope which may have been caused by low cardiac output or possibly a transient ischaemic attack. Many patients present with non-specific signs of a PE and in up to 40% of cases no predisposing factors are present.³

The only predisposing factor in this patient was a sedentary lifestyle and evidence of dehydration.

A PFO increases the risk of ischaemic stroke due to paradoxical embolism in patients with acute PE and RV dysfunction.⁴ Thrombus-in-transit is an uncommon phenomenon that requires a high level of clinical suspicion to make a diagnosis. In acute PE, the embolism will travel across the PFO because of the physiological changes that occur i.e. elevated right-sided pressures and systemic hypotension.

Factors associated with a high risk of mortality in PE include symptoms and signs of overt RV failure, haemodynamic instability, syncope, right heart thrombus, and PFO with right to left shunt, all of which were present in this patient. Other markers associated with the poor outcome are increased lactate, troponin, and creatinine—all of which were mildly elevated in this patient.³

The concomitant presence of right heart thrombus and pulmonary embolism (PE) is an extreme emergency because the mortality rate is increased beyond PE alone.⁵ ESC guidelines recommendations are based on the severity of patients' condition. In this high-risk patient, the initial treatment guidelines were followed i.e. administer supplemental oxygen, initiate anticoagulation as soon as possible, use a fluid bolus for resuscitation and consider vasopressors (noradrenaline was commenced preinduction). Treatment options include surgical thrombectomy of the right atrium or the pulmonary artery and/or medical therapy such as thrombolysis and anticoagulation. Surgical embolectomy is usually preferred for patients with free-floating ventricular thrombus. In this case, the risk of thrombolysis in the presence of left atrial floating thrombus was prohibitive and the clinical decision was made rapidly to proceed to surgery.

Caution on the induction of anaesthesia is imperative as the patient is highly susceptible to the development of severe cardiac instability. The patient was induced in theatre with surgeons present but fortunately remained relatively cardiovascularly stable with fluid and vasopressor therapy.

Surgical embolectomy in acute PE is usually carried out with cardiopulmonary bypass, without aortic cross-clamping and cardioplegic cardiac arrest, followed by incision of the two main pulmonary arteries with the removal or suction of fresh clots. Recent reports have indicated favourable surgical results in high-risk PE, with or without cardiac arrest, and in selected cases of intermediate-risk PE.²

Acute severe RV failure is associated with high mortality up to 86% and therapeutic aims are to optimize the preload, reduce the afterload and improve the contractility—ephedrine is the first-line therapy for this and inhaled nitric oxide may be used as a pulmonary vasodilator although evidence for mortality benefit is lacking.⁶ When these measures are not sufficient, early mechanical support may reduce complications from hypotension and low cardiac output. The temporary use of mechanical cardiopulmonary support, mostly with veno-arterial ECMO, may be helpful in patients with high-risk PE. Survival of critically ill patients has been described in a number of case series.⁷ Preoperative ECMO has also been used successfully in patients who are in the cardiogenic shock prior to transfer to the operating theatre.

Conclusion

We report a case of massive pulmonary embolism with extensive thrombus-in-transit. Despite him having multiple factors predicting

poor prognosis, he was successfully discharged home after 43 days in hospital. Prompt diagnosis and rapid management allowed this young patient to survive an extremely life-threatening condition.

Lead author biography



Dr Helen Saunders graduated from Liverpool Medical School and worked as a consultant cardiothoracic anaesthetist in Lancashire Cardiac Centre, UK for 10 years before moving to work in a new purpose built state of the art cardiac centre in the Kingdom of Bahrain in 2019. In Lancashire, she developed pathways in enhanced recovery in cardiac surgery and became the director of Scheduled care. Interests

include perioperative TOE and medical leadership. Out of work, she enjoys paddle boarding and yoga.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing these cases and suitable for local presentation is available online as [Supplementary data](#).

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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