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CASE REPORT
Structural intervention

Large-bore suction thrombectomy for sub-massive pulmonary embolism during second trimester of pregnancy: a case report

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Background Pregnancy-associated pulmonary embolism (PAPE) remains a significant cause of maternal mortality. Anticoagulation remains the mainstay of therapy for most pulmonary embolism (PE)-related pregnancies. However, in patients with haemodynamic compromise or those refractory to anticoagulation, management is challenging. Systemic thrombolysis is associated with a substantial risk of maternal bleeding and fetal loss. In non-pregnant PE patients, large bore catheter-directed suction thrombectomy is a proven and important technique to manage intermediate or high-risk PE, allowing for normalization of pulmonary pressures, avoidance of haemodynamic deterioration, without the need for thrombolytics, major surgery, significant blood loss, or prolonged hospitalization.

Case summary A primigravid patient in her second trimester of pregnancy, initially diagnosed with a deep vein thrombosis refractory to heparin, presents with near-syncope due to sub-massive pulmonary embolism. The various management options including thrombolysis and surgical embolectomy etc. were discussed in detail by a multi-disciplinary PE team. She underwent large bore suction thrombectomy with complete thrombi removal, normalization of right heart strain, without the need for thrombolytics or surgery, minimal blood loss and was discharged after a short length of stay. She gave birth at term to a healthy infant.

Conclusion Suction thrombectomy is an important consideration for physicians managing high-risk PAPE and is likely to be associated with much a lower risk of maternal and fetal mortality compared to thrombolysis or surgery.

Keywords Pregnancy • Pulmonary embolism • Thrombectomy • Catheter • Case report

ESC curriculum 9.5 Pulmonary thromboembolism • 9.8 Pregnancy with cardiac symptoms or disease • 6.7 Right heart dysfunction • 7.1 Haemodynamic instability

Learning points

Case: Sub-massive or intermediate-high risk pulmonary embolism (PE) during the second trimester of pregnancy

- Recognize pregnancy as a pro-thrombotic state and understand the techniques to diagnose pregnancy-associated pulmonary embolism.
- Be cognizant of the range of therapeutic options for managing pregnancy-associated PE and their associated risk-benefit ratios.
- Catheter-directed suction thrombectomy can be safely performed in the majority of patients with immediate restoration of normal hemodynamics, without the need for major surgery, significant blood loss, X-ray contrast, or thrombolytics.

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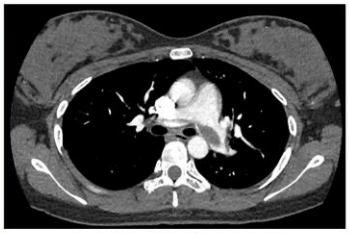
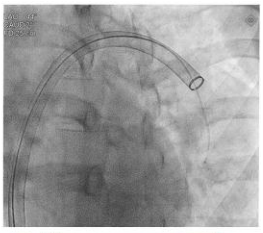
Introduction

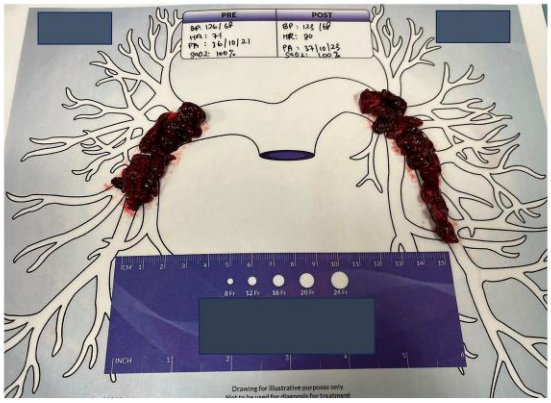
Pregnancy-associated pulmonary embolism (PAPE) remains a significant cause of maternal mortality. Anticoagulation remains the mainstay of therapy for most pulmonary embolism (PE)-related pregnancies. However, in patients with haemodynamic compromise or those refractory to anticoagulation, management is challenging. Systemic thrombolysis is associated with a substantial risk of maternal bleeding and fetal loss. In non-pregnant PE patients, large bore catheter-directed suction thrombectomy is a proven and important technique to manage intermediate or high-risk PE, allowing for normalization of pulmonary pressures, avoidance of haemodynamic deterioration, without the need for thrombolytics, major surgery, significant blood loss or prolonged hospitalization.[1,2] This technique is likely to be associated with a lower risk of maternal and fetal mortality compared to thrombolysis or surgery, and should be considered in PAPE.

Summary figure

Gestational Age	Events
19th week	Diagnosis of unilateral DVT; low molecular weight heparin started
22nd week	Presented with breathlessness, chest discomfort, near syncope. Intermediate high-risk saddle and bilateral PE Underwent large bore suction pulmonary thrombectomy
23rd week	Discharged on warfarin
39th week	Uncomplicated delivery at full term







Case presentation

A 25-year-old, 19 weeks primigravid female, without any prior health issues, family history of venous thromboembolism recent travel presented with a unilateral, right leg swelling. Ultrasound venography revealed an extensive deep vein thrombosis (DVT) extending from her right posterior tibial vein into the right external iliac vein. She was commenced on subcutaneous low-molecular weight heparin (enoxaparin 1.5 mg/kg once daily) for treatment of her DVT. 3 weeks later, she presented with sudden onset breathlessness and chest discomfort. Upon climbing a flight of stairs, she experienced severe dizziness. Physical examination revealed unresolving right leg swelling, normal heart, and breath sounds. Her blood pressure was 110/70 mmHg with a regular pulse of 85 beats per minute. Her oxygen saturation was 95% on room air. Her electrocardiogram showed sinus rhythm with an S1Q3T3 pattern. (*Figure 1*) Transthoracic echocardiography was performed which revealed a grossly dilated right ventricle with good contractility. Left ventricular ejection fraction was normal but the ventricular septum was flattened due to elevated right ventricular pressures. The estimated pulmonary artery systolic pressure (PASP) based on echocardiography was 51 mmHg, consistent with moderate pulmonary hypertension. The clinical suspicion of PE was high and therefore she was counselled to undergo computed tomography pulmonary angiography which confirmed the presence of saddle and bilateral PE. (*Figure 2*) N-terminal pro-B-type natriuretic peptide levels were elevated at 276 pg/mL (normal < 125 pg/mL).

She was admitted urgently and a multi-disciplinary discussion with the patient and her family was held. The diagnosis of intermediate-high risk PE according to the European Society of Cardiology PE risk stratification scheme was explained.[3] Of greater concern was that PE developed despite compliance with 3 weeks of therapeutic enoxaparin therapy for a proven DVT. The risk-benefit of the following treatment options were discussed in detail: (see Supplementary material online, *Table S1*)

1. Conservative therapy with continued enoxaparin therapy with potential escalation to systemic thrombolysis in the event of further haemodynamic decompensation.
2. Pre-emptive systemic thrombolysis using either a half- or full-dose regime to reduce PE clot burden, although this is not recommended in guidelines for normotensive PE.[3]
3. Catheter-directed thrombolysis which would involve smaller doses of intrapulmonary thrombolytics but also limited radiation exposure to introduce the catheters into the pulmonary arteries.
4. Suction thrombectomy which would not require any thrombolytics and is associated with minimal blood loss, but would also require radiation exposure to perform the procedure.
5. Surgical embolectomy which would involve open chest surgery and cardiopulmonary bypass.

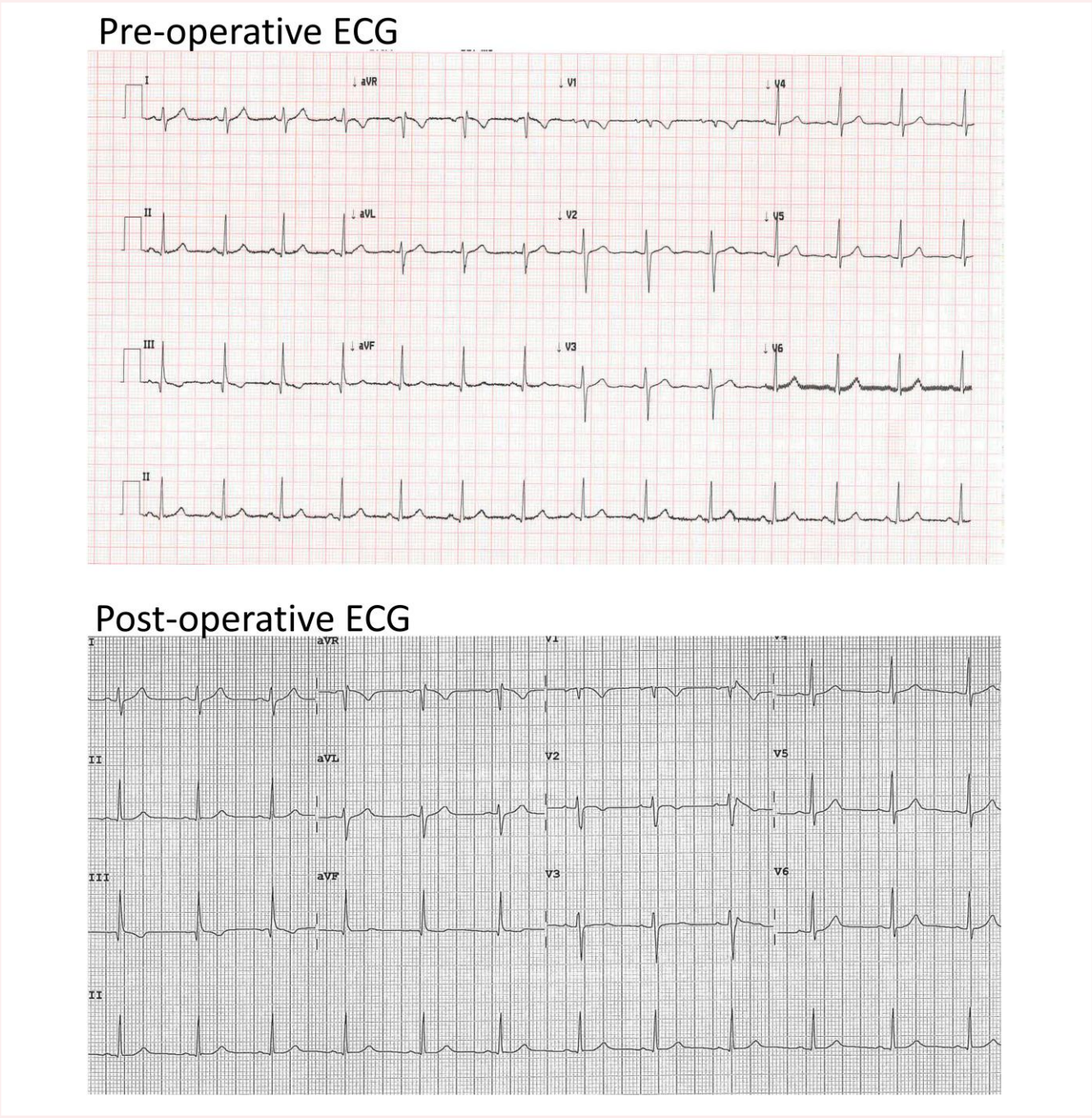


Figure 1 Electrocardiograms before (upper panel) and after (lower panel) thrombectomy.

6. Extra-corporeal membrane oxygenation which would provide circulatory support, in the event of haemodynamic decompensation, as a bridge to reperfusion therapies.

Based on shared decision-making between the patient, her family, and the multi-disciplinary pulmonary embolism response team (PERT), she elected to undergo semi-emergent suction thrombectomy. Upon admission to the high-dependency care unit, she was switched from enoxaparin to unfractionated heparin infusion. It was then realized that she required 1600 IU/h (38 400 IU/day) of unfractionated heparin to achieve an activated partial thromboplastin time of 70 s. Thus, heparin resistance may explain failure of enoxaparin to treat her DVT and prevent her subsequent PE. A pre-procedural obstetric assessment and antenatal scan confirmed the foetus as well.

In the cardiac catheterization laboratory, her abdomen, pelvis, and left thigh were draped with lead skirts to minimize radiation exposure to the foetus. A single right common femoral venous access was achieved under ultrasonic guidance with a micropuncture set. Ultrasonography also confirmed that the right femoral vein and inferior vena cava were free from thrombus. The access site was progressively dilated until a 28 French sheath (Intri, Inari Medical, CA, USA) could be positioned in the inferior vena cava. Direct contrast pulmonary angiography was avoided to minimize radiation dose and as such no contrast

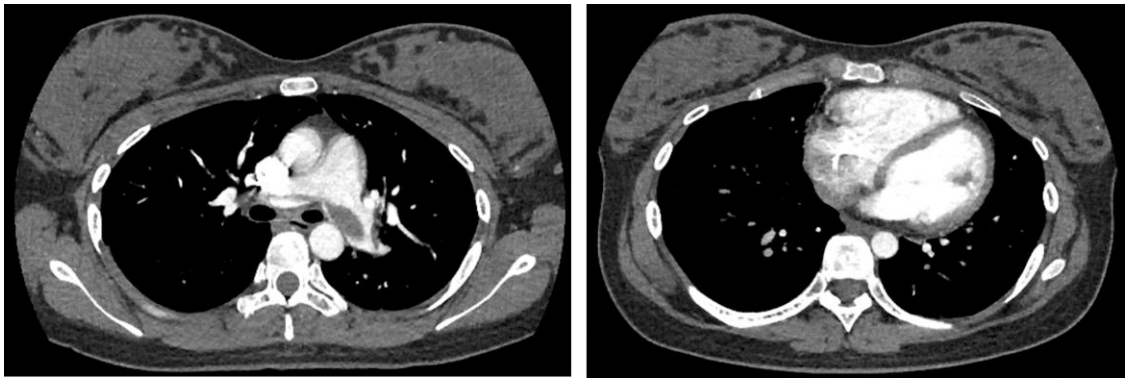


Figure 2 Computed tomography pulmonary angiography. The left panel shows the presence of bilateral pulmonary embolism and a saddle embolus straddling the left and right pulmonary arteries. The right panel shows the dilated right ventricle with a right ventricle:LV ratio of more than 1.3.

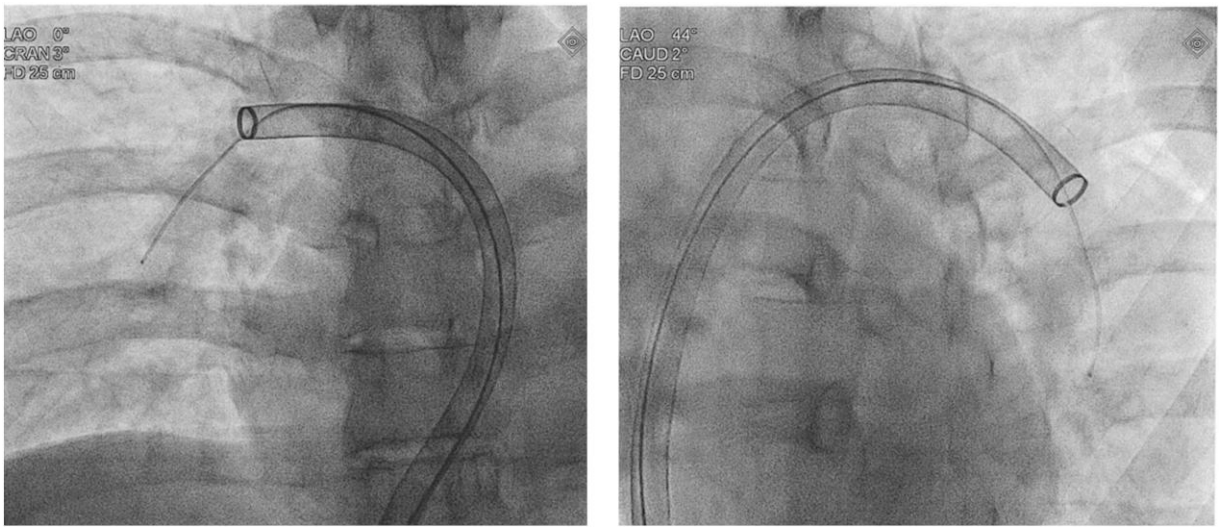


Figure 3 Suction thrombectomy catheters within the left and right pulmonary arteries.

was used throughout the procedure. Less than 3 min of low-dose fluoroscopy was used to position the guidewire distally within the left and right pulmonary arteries. (*Figure 3*) Suction thrombectomy was performed by applying aspiration to large bore catheters (T20 curve and T24 catheters, Inari Medical, CA, USA) and gradually withdrawing these catheters into the main pulmonary artery (PA). At least 3 runs were made in each pulmonary artery. Large volumes of clots were aspirated, with the aspirated blood passed through a micro-filter (FlowSaver, Inari Medical, CA, USA) before being re-infused via the femoral sheath (*Figure 4*). Post-thrombectomy, pulmonary arterial pressures had normalized to 33/12 mmHg (mean PA pressure of 21 mmHg) compared to 50/14 mmHg (mean PA pressure of 30 mmHg) at the start of the procedure. Oxygen saturation was 99% without the need for supplementary oxygen. Blood loss was estimated at less than 100 mLs. A figure of eight subcutaneous suture was placed at the access site to achieve hemostasis after catheter removal. This suture was removed the next day without any access site complications. Post-thrombectomy, the repeat obstetric scan remained normal with a viable, non-distressed fetus. A repeat echocardiogram 5 days later before discharge demonstrated normal right heart size and function and normal estimated PASP of only 32 mmHg. Her cardio-respiratory symptoms had resolved completely. Given her non-resolving DVT with enoxaparin, she was anticoagulated with 5 mg warfarin for the remainder of her pregnancy, aiming for a target International Normalized ratio of between 2.0 and 3.0. Maternal use of warfarin from week 6 to week 12 of gestation is associated with a risk of warfarin embryopathy due to impaired fetal synthesis of Vitamin K-dependent proteins crucial for bone and cartilage formation. Given that the pregnancy was already entering the 20th week of gestation, the obstetrician assessed the risk of fetal harm from warfarin to be low. A thrombophilia screen was performed which was negative. She delivered a healthy baby 4 months later at full term. She remained asymptomatic and free from recurrent venous thromboembolism or pulmonary hypertension at her last follow-up more than 7 months post-partum, still on warfarin.

Discussion

PAPE affects 1 in 1000 to 3000 pregnancies and in developed countries, high risk PE accounts for 10% to 15% of maternal deaths.[4] The current

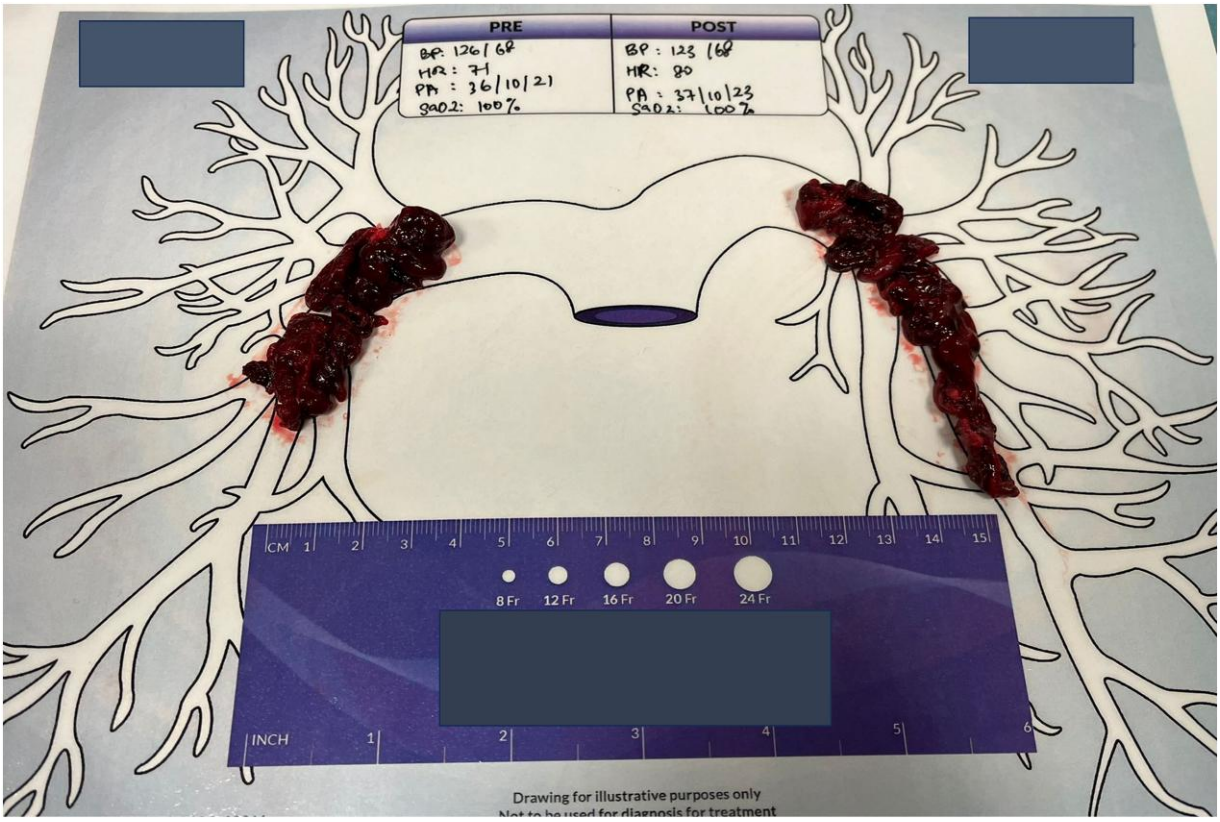


Figure 4 Thrombi aspirated from both pulmonary arteries and displayed on a A4 schematic of the pulmonary arterial tree.

guidelines recommend anticoagulation as the mainstay for treating PAPE and unanimously reserve systemic thrombolysis for life-threatening PE associated with haemodynamic decompensation.[3] In the non-pregnant population, such massive PE is associated with in-hospital mortality in excess of 30%.[5] When given as the treatment of last resort for massive PAPE, thrombolysis is associated with an 18% risk of antepartum bleeding, 58% risk of post-partum bleeding, 18.5% risk of fetal death, 13.5% risk of spontaneous labour and at least 6% risk of maternal death.[4] Such risks are exceedingly high for women who are otherwise generally in good health. Before the availability of equipment designed specifically for PE intervention, small numbers of PAPE were treated with surgical embolectomy or stabilized with veno-atrial extra-corporeal membrane oxygenation. In small case series, maternal and fetal survival rates following the latter two therapies were usually below 80%.

In recent years, suction thrombectomy to aspirate pulmonary emboli has been proven to normalize right heart strain, prevent haemodynamic deterioration by rapid removal of pulmonary clot burden, using a minimally invasive percutaneous approach, without the need for thrombolytics, or general anaesthesia.[1,2] Post-operative recovery is short with most patients requiring high-dependency care for less than 1 day. Of 800 patients treated with suction thrombectomy in the FLASH registry, of which 84.6% had intermediate or high risk PE, all cause mortality at 30 days was only 1.8%, significantly better survival compared to historical cohorts managed with anticoagulation and thrombolysis as a last resort.[1] In this study, it was also recognized that 34% of intermediate-risk PE patients had normotensive shock as defined by a systolic pressure of more than 90 mmHg but cardiac index of less than 2.2 L/min/m^2.[6]

There are growing numbers of case reports in the literature of catheter-directed therapies, using equipment dedicated to PE intervention in PAPE, with good short-term results.[7,8] The formulation of an individualized treatment plan for each PE patient and use of catheter-directed therapies should ideally directed by a multidisciplinary PERT, as shown here.[5] This case highlights the novel application of large bore catheter-directed suction thrombectomy to PAPE, as a promising and useful technique to manage these difficult cases, allowing for quick normalization of pulmonary pressures, avoidance of haemodynamic deterioration, without the need for thrombolytics, major surgery, significant blood loss or prolonged hospitalization.

Lead author biography

Dr Pipin Kojodjojo is a senior consultant cardiologist at Asian Heart and Vascular Centre, Singapore. He graduated from St. Bartholomew's and Royal London Hospital Medical School, University of London in 1998 and underwent training in cardiology and cardiac electrophysiology at St. Mary's Hospital, Imperial College London, UK and Brigham and Women's Hospital, Boston, USA. In addition, he launched the first Pulmonary Embolism Response Team in Southeast Asia in 2014 and was the first to perform large bore suction pulmonary thrombectomy in Asia Pacific. He provides mentorship to a growing number of Pulmonary Embolism Response Teams in Singapore and Southeast Asia.

Supplementary material

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

Consent: The patient has given informed written consent for the publication of this anonymized case report. The written consent form is compliant with COPE guidelines.

Conflict of interest: None declared.

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Data availability

Anonymized data underlying this article will be shared on reasonable request to the corresponding author.

References

1. Toma C, Jaber WA, Weinberg MD, Bunte MC, Khandhar S, Stegman B, *et al.* Acute outcomes for the full US cohort of the FLASH mechanical thrombectomy registry in pulmonary embolism. *EuroIntervention* 2022;**18**:e929–e932.
2. Kojodjojo P, Ong HA, Loh PH, Tay E, Chang P, Kuntjoro I, *et al.* First use of large-bore suction thrombectomy for acute pulmonary embolism in Asia-Pacific: feasibility and short-term clinical outcomes. *J Thromb Thrombolysis* 2023;**55**:660–666.
3. Konstantinides SV, Meyer G. The 2019 ESC guidelines on the diagnosis and management of acute pulmonary embolism. *Eur Heart J* 2019;**40**:3453–3455.
4. Blondon M, Martinez de Tejada B, Glauser F, Righini M, Robert-Ebadi H. Management of high-risk pulmonary embolism in pregnancy. *Thromb Res* 2021;**204**:57–65.
5. Jen WY, Kristanto W, Teo L, Phua J, Yip HS, MacLaren G, *et al.* Assessing the impact of a pulmonary embolism response team and treatment protocol on patients presenting with acute pulmonary embolism. *Heart Lung Circ* 2020;**29**:345–353.
6. Bangalore S, Horowitz JM, Beam D, Jaber WA, Khandhar S, Toma C, *et al.* Prevalence and predictors of cardiogenic shock in intermediate-risk pulmonary embolism: insights from the FLASH registry. *JACC Cardiovasc Interv* 2023;**16**:958–972.
7. Compadre AJ, Kohi M, Lokken RP, Blissett S, Harris IS, Lucero J, *et al.* Catheter-directed thrombolysis for submassive pulmonary embolism in the third trimester of pregnancy. *JACC Case Rep* 2020;**2**:1899–1904.
8. Poor H, Serrao G, Grapsa J, Chandrashekhar YS, Bianco A, Lookstein RA, *et al.* High-risk pulmonary embolism during labor: JACC patient care pathways. *J Am Coll Cardiol* 2023;**81**:283–291.