

Case Report

Aspiration Thrombectomy for Intermediate-Risk Pulmonary Embolism

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Although systemic thrombolytic therapy is recommended for pulmonary embolism (PE) resulting in hypotension, termed “high-risk” PE, the treatment of submassive (“intermediate-risk”) PE is more nuanced. Systemic or catheter-directed thrombolysis and surgery are treatment options for intermediate-risk PE with high-risk features, such as elevated cardiac biomarkers or right ventricular dysfunction. However, thrombolysis and surgery carry significant bleeding and perioperative risks. We present 2 cases of patients with intermediate-risk PE who underwent aspiration thrombectomy with rapid hemodynamic improvement.


Patient 1

Past medical history

A 72-year-old male patient with urothelial carcinoma presented from urgent care with 5 days of progressive dyspnea on exertion.

Investigations

On arrival, the patient’s vital signs were remarkable for a blood pressure of 93/67 mm Hg and a heart rate of 114 beats per minute (bpm). Oxygen saturation on room air was 93%, with a respiratory rate of 20 breaths per minute. Laboratory test results showed a high-sensitivity troponin level of 0.12 ng/mL (reference range: < 0.032 ng/mL), and a brain natriuretic peptide level of 440 pg/mL (reference range: < 100 pg/mL); an electrocardiogram showed sinus tachycardia. His D-dimer level was 1180 mcg/L (reference range: < 500 mcg/L). A

computed tomography pulmonary angiogram showed extensive bilateral PEs, with a large thrombus in the right ventricle (RV), and an increased RV-to-left-ventricle ratio (Fig. 1, A and B). A formal transthoracic echocardiogram (TTE) showed a severely enlarged RV cavity with a large mobile thrombus in the RV (Video 1 , view video online).

Patient 2

Past medical history

A 65-year-old male patient with a history of hypertension presented with syncope while ambulating.

Investigations

On arrival, the patient had an oxygen saturation of 93% on room air, with a respiratory rate of 22 breaths per minute. His heart rate was 92 bpm, and the physical examinations were unremarkable. His D-dimer level was 3600 mcg/mL (reference range: < 400 mcg/mL). The initial high-sensitivity troponin level was 0.053 ng/mL (reference range: < 0.032 ng/mL), his brain natriuretic peptide level was 616 pg/mL (reference range: < 100 pg/mL), and an electrocardiogram showed an incomplete right bundle branch block. A computed tomography pulmonary angiogram showed large bilateral PEs, with evidence of right heart strain (Fig. 1, C and D). A formal TTE showed severe RV dysfunction and evidence of RV pressure overload (Supplemental Fig. S1, B and C).

Management

For both patients, an urgent multidisciplinary case review with interventional cardiology, interventional radiology, and advanced heart failure consultants deemed systemic thrombolysis inappropriate, due to lack of systemic hypotension in both patients and a prohibitively high risk of causing further embolization of the mobile RV thrombus in patient 1. Further, patient 1 was felt to have an elevated bleeding risk with surgery

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Novel Teaching Points

- PEs resulting in hypotension are considered high-risk. A PE is termed “intermediate-risk” if normotension is present in addition to radiographic evidence of RV dysfunction or an elevated troponin level.
- Thrombolytics are recommended for high-risk PE; the treatment for intermediate-risk PE is more nuanced.
- Although concomitant right-sided thrombus predicts a potentially fatal PE, further clot embolization can occur with thrombolysis.
- Aspiration thrombectomy is a treatment option for intermediate-risk PE that obviates the risks of thrombolysis, especially in the setting of concomitant right-sided thrombi.

and catheter-directed thrombolysis, owing to his age and cancer history. Patient 2 was felt to have an elevated risk, owing to a > 20 mm Hg drop in his blood pressure early in the hospital course, although his systolic blood pressure never dropped below 90 mm Hg. Both patients were loaded with 80 units/kg of intravenous heparin and were started on a therapeutic heparin drip with an anti-Xa goal of 0.3-0.7 units/mL.

Given the high-risk features—including a large clot burden, radiographic evidence of RV dysfunction, evidence of myocardial injury, the life-threatening nature of the mobile

right-sided thrombus, the systolic blood pressure of < 100 mm Hg, plus the elevated bleeding risk—in patient 1, and the declining blood pressure in patient 2, both underwent emergent thrombectomy. Intraprocedural transesophageal echocardiogram showed a large right-sided thrombus in patient 1 (Supplemental Fig. S1), who underwent thrombectomy of approximately 15 cm of tubular clot extending from the right atrium to the RV outflow tract with FlowTriever (Inari Medical, Irvine, CA; Fig. 2). After a single aspiration, no evidence of thrombus was present on transesophageal echocardiogram. The patient’s heart rate and blood pressure changed from 96/65 mm Hg and 114 bpm, respectively, before the case, to 101/79 mm Hg and 80 bpm after the thrombectomy. Similarly, patient 2 had a rapid reduction in measured pulmonary artery pressure; his blood pressure and heart rate were 98/55 mm Hg and 90 bpm, respectively, before, and 106/68 mm Hg and 72 bpm after thrombectomy. The times from identification of PE to aspiration thrombectomy in patients 1 and 2 were 3 and 8 hours, respectively. Both patients were transferred out of the intensive care unit the following morning and were discharged on hospital day 3 on indefinite direct oral anticoagulation, given the unprovoked nature of their PEs.

Discussion

The 2019 European Society of Cardiology PE Guidelines recommend thrombolytic therapy for hemodynamically significant PE, and consideration of surgical embolectomy or

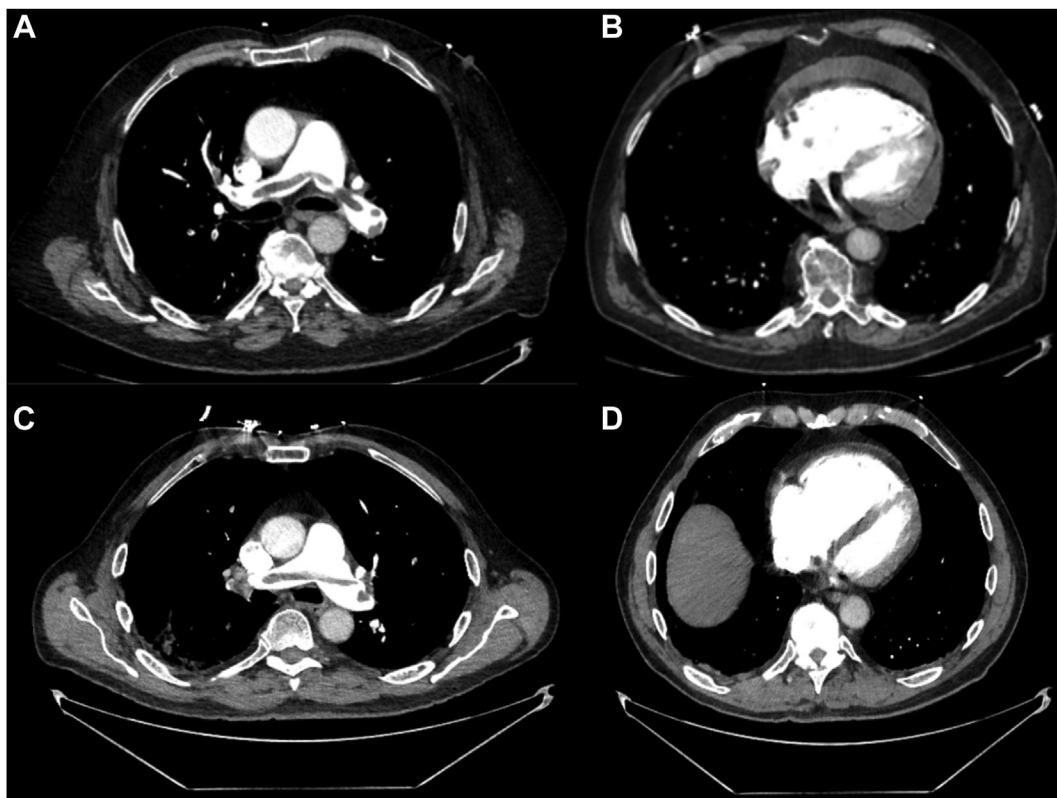


Figure 1. Computed tomography showing saddle pulmonary embolus with an increased right-ventricular-to-left-ventricular ratio in (A, B) patient 1 and (C, D) patient 2.

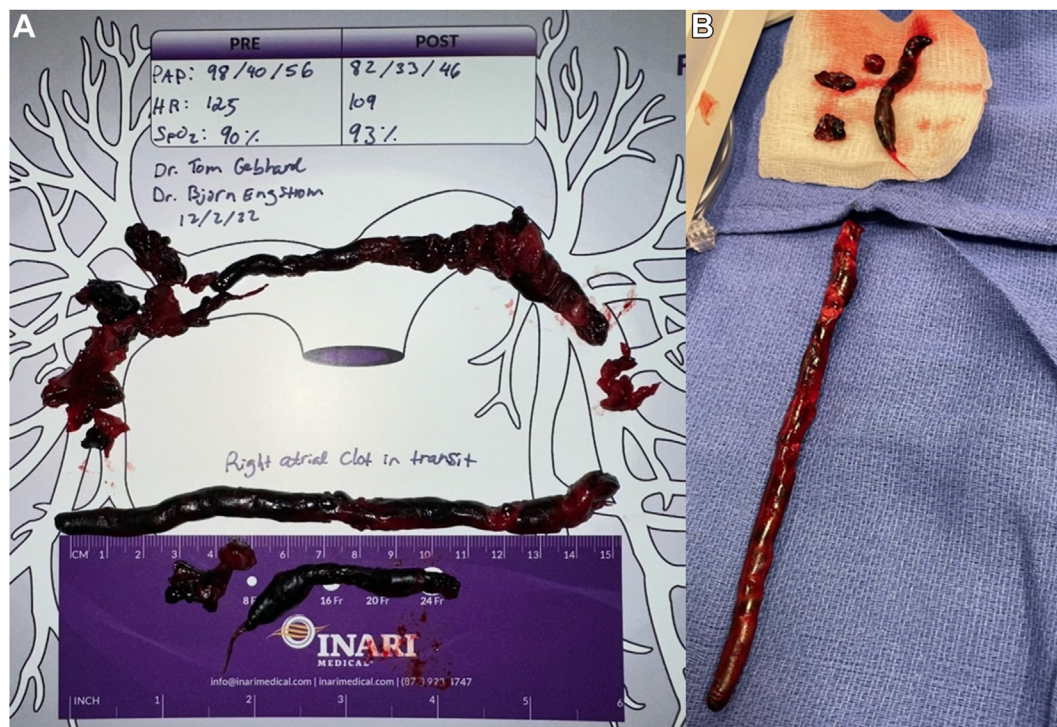


Figure 2. Tubular clot from pulmonary artery after removal in (A) patient 1 and (B) patient 2. HR, heart rate; PAP, pulmonary arterial pressure; SpO₂, oxygen saturation.

catheter-directed thrombolysis in patients for whom thrombolysis is contraindicated or has failed.¹ Although rescue thrombolytic therapy is recommended for intermediate-risk patients with hemodynamic deterioration, no recommendations have been made on the use of catheter-directed treatment for intermediate-risk PE in the absence of hemodynamic deterioration.

Our case suggests the potential efficacy of aspiration thrombectomy in patients with intermediate-risk PE, especially those who have concomitant right-sided thrombus, high bleeding risk, or clot-in-transit. The benefits are 4-fold. First, the procedure offers the option of removing concomitant right atrial thrombus that can be a nidus for further embolization and subsequent life-threatening hemodynamic decompensation. Second, it allows for the immediate removal of a large clot burden. Third, aspiration thrombectomy is less invasive—no surgery or cardiopulmonary bypass is required. Fourth, it circumvents the risks of thrombolytics and surgery. These benefits need to be balanced with device availability and institutional expertise, the bleeding risk from large-bore vascular access, and the procedural cost.

Right atrial thrombus is a predictor of a potentially fatal PE. Right atrial thrombi associated with PE are usually serpiginous and highly mobile. Unfortunately, only a dearth of guidelines are available on right-sided thrombus management, especially in high-risk patients. Rose et al. reported a higher complication rate in patients who received anticoagulation and surgery, compared to thrombolysis, but a risk of potentially fatal clot embolization comes with thrombolysis.²

Thrombolytics in intermediate-risk PE reduce mortality at the expense of intracranial hemorrhage and life-threatening bleeding. One meta-analysis of 2057 patients who received

fibrinolysis for PE found a high risk of major hemorrhage (odds ratio: 2.91; 95% confidence interval: 1.95-4.36).³ The placebo-controlled **Pulmonary Embolism Thrombolysis (PEITHO)** trial found that tenecteplase reduces all-cause death or hemodynamic decompensation in intermediate-risk PE (2.6% vs 5.6%; odds ratio: 0.4; 95% confidence interval: 0.23-0.88). A higher risk of intracranial bleeding was seen in the thrombolysis group, leading to the recommendation against thrombolysis in the absence of hemodynamic compromise.^{1,4}

However, risk is a continuum and is not binary. Further, risk is relevant to only a snapshot in time; in clinical practice, both the risk and the trend are considered. For example, patient 1 was an intermediate-risk patient who had features that the shock team considered high risk, such as systolic blood pressure in the 90s mm Hg, and heart rate in the 110s bpm. These are supported as risk-enhancing factors in the European Society of Cardiology guidelines. Similarly, the declining blood pressure in patient 2 was considered a worrisome sign, despite neither patient having a systolic blood pressure < 90 mm Hg. The combination of the vital signs and biochemical and radiographic evidence of RV dysfunction in both patients, plus the high bleeding risk and the thrombus-in-transit in patient 1, prompted the shock-team decision to pursue early intervention.

The cost and recovery time of surgical embolectomy, the bleeding risks of thrombolytic therapy, and the dearth of effective options for concomitant right atrial thrombi make aspiration thrombectomy a potentially useful treatment in patients with intermediate-risk PEs. One single-arm study of 106 patients undergoing aspiration thrombectomy for intermediate-risk PE found improvement in the RV-to-left-ventricle ratio and minimal major bleeding.⁵ The ongoing Prospective, multicenter, randomized controlled trial of the

FlowTrierer System compared to Catheter-Directed Thrombolysis (PEERLESS) randomized aspiration thrombectomy to catheter-directed thrombolysis in intermediate-to-high-risk patients (NCT05111613).

Conclusion

Guidelines currently recommend systemic thrombolysis for patients with hemodynamically unstable PE, and surgical thrombectomy or catheter-directed thrombolytics for patients in whom thrombolytics either are contraindicated or have failed. No current guideline recommendations have been developed on reperfusion therapy in hemodynamically stable intermediate-risk PE, and no interventions have shown a survival benefit in a randomized trial. However, in our patients, the immediate normalization of vital signs, reduction in invasive pulmonary arterial pressure, resolution of RV strain on follow-up TTE, and short hospital stays support aspiration thrombectomy as a novel treatment that may obviate the risks of surgery and thrombolysis, especially in patients with a high bleeding risk or concomitant right-sided thrombi.

Ethics Statement

The cases reported in the manuscript adhered to the institutional informed consent guidelines.

Patient Consent

Written informed consent was obtained from both patients for this article.

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Disclosures

The authors have no conflicts of interest to disclose.

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Supplementary Material

To access the supplementary material accompanying this article, visit *CJC Open* at <https://www.cjopen.ca/> and at <https://doi.org/10.1016/j.cjco.2024.04.011>.