Open Access

Article Type: Case Report

Volume 2 Issue 2 - 2024

SCIBASE Journals

SciBase Surgery

Thrombo-Aspiration in a High-Risk Case of Pulmonary Embolism

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Article Information

Received: Aug 15, 2024

Accepted: Oct 03, 2024

Published: Oct 10, 2024

SciBase Epidemiology and Public Health - scibasejournals.org

Citation: Angelini GD, Maharaj S, Mc Carthy AM, Martinez J, Gomez C, et al. Thrombo-Aspiration in a High-Risk Case of Pulmonary Embolism. SciBase Surg. 2024; 2(2): 1011.

Abstract

Pulmonary Embolism (PE) is a serious medical condition with high short and long term morbidity and mortality, which requires immediate diagnosis and treatment. Catheter-directed therapies should be considered more often when treating intermediate and high-risk patients as they provide faster and more effective results for reperfusion and positive clinical outcomes with better long-term prognosis compared to thrombolysis.

We report a case of a 75-year-old male patient who had a one-day history of dyspnoea then syncope and presented with shortness of breath and tachycardia. His Computed Tomography (CT) pulmonary angiogram scan revealed extensive acute bilateral pulmonary emboli with signs of right-sided cardiac dysfunction. The patient underwent successful pulmonary thrombo-aspiration using the PENUMBRA INDIGO system, demonstrating its safety and efficacy.

Keywords: Pulmonary embolism; Pulmonary Thrombo-aspiration; PENUMBRA INDIGO system; Computed tomography (CT); Pulmonary angiogram; Right ventricular systolic pressure (RVSP).

Introduction

Pulmonary Embolism (PE) presents with acute symptoms including dyspnoea, syncope and tachycardia, often precipitated by predisposing factors such as prior deep vein thrombosis. This case presentation involves a 75-year-old male with a history of deep vein thrombosis. Initial findings included an abnormal ECG, elevated D-dimer and pro-BNP levels. Computed tomography pulmonary angiogram confirmed extensive bilateral pulmonary emboli with signs of right-sided cardiac dysfunction. Following diagnostic confirmation, the patient underwent successful pulmonary thrombo-aspiration using the PENUMBRA INDIGO Aspiration System, resulting in significant thrombus removal and haemodynamic stabilization. This case shows the effectiveness of catheter-based intervention in managing high-risk PE when systemic thrombolysis is contraindicated.

Case presentation

A 75-year-old male presented with a one-day history of dyspnoea then syncope, shortness of breath and tachycardia. He had a history of deep vein thrombosis four years before, after a long flight and was on aspirin and testosterone replacement therapy.

Electrocardiogram (ECG) showed sinus rhythm, S wave in lead I, inverted T wave in Lead III and V_1-V_5, no ST abnormalities, marked left axis deviation, and incomplete right bundle branch block (Figure 1). The D-dimer was elevated, Troponin was <0.01 ng/mL and pro-B-type natriuretic peptide (pro-BNP) was elevated at 1,577 pg/mL. He had a Wells score of 6, and the Computed Tomography pulmonary angiogram (CTPA) scan revealed extensive acute bilateral pulmonary emboli with features of right-sided cardiac dysfunction (Figure 2). The emboli were noted in the main lower lobe pulmonary arteries, bilaterally, as well as in the right upper lobe segmental pulmonary arteries.

The ECHO showed flattening of the interventricular septum in systole, a dilated right ventricle with normal systolic function with Tricuspid Annular Plane Systolic Excursion (TAPSE): 18mm, dilated right atrium, mild tricuspid valve regurgitation with mildly increased Right Ventricular Systolic Pressure (RVSP): 44mmHg. In view of the foregoing, a diagnosis of sub-massive pulmonary embolism was made. After extensive counselling with the patient and the cardiology team, it was opted to proceed to pulmonary thrombo-aspiration.

Right catheterisation was performed, and the pressure was measured with Cournand and 6Fr Pigtail catheters; the right atrium had a pressure of 12/8 (7) mmHg, and the pulmonary artery had a pressure of 60/24 (36) mmHg. A pulmonary angiogram was performed, and the bilateral opaque defect was observed in the segmental and sub-segmental branches (Figure 3A & 3C). The PENUMBRA INDIGO system CAT8 catheter and SEP8 separator were used where the separator facilitated the clearing of the emboli from the catheter tip (Figure 4). The thrombotic aspiration was performed in both sides, obtaining large amounts of thrombotic material. Approximately 40% of the clot was removed from both pulmonary arteries with approximately 400 ml of blood from the pulmonary circulation (Figure 3B & 3D). The patient was haemodynamically stable during and post-procedure. His total hospital stay was 2 days which was uneventful. He had no bleeding post-op. A non-vitamin K antagonist anticoagulant (NOAC), Xarelto (Rivaroxaban), was started after the procedure.

The ECHO before discharge showed flattening of the interventricular septum in systole, a dilated right ventricle with normal systolic function with TAPSE: 21 mm, dilated right atrium, mild tricuspid valve regurgitation with RVSP: 38 mmHg.

A transthoracic echocardiogram performed one year later showed a non-dilated left ventricle, with an estimated ejection fraction of 60%, grade 1 diastolic left ventricular dysfunction, right ventricular dilation, normal right atrium, and no tricuspid regurgitation, with normal RVSP and TAPSE.

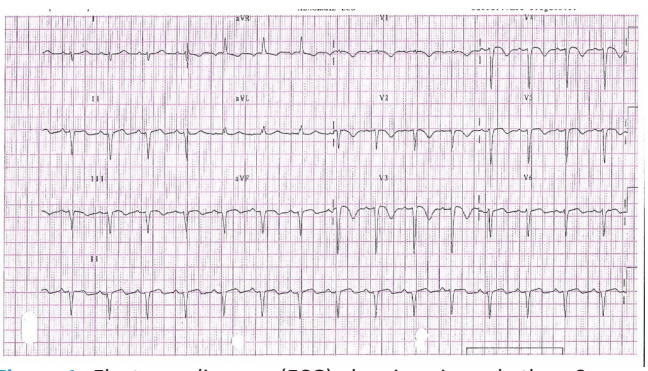

Figure 1: Electrocardiogram (ECG) showing sinus rhythm, S wave in lead I, inverted T wave in Lead III and V1-V5, no ST abnormalities, marked left axis deviation, and incomplete right bundle branch block.

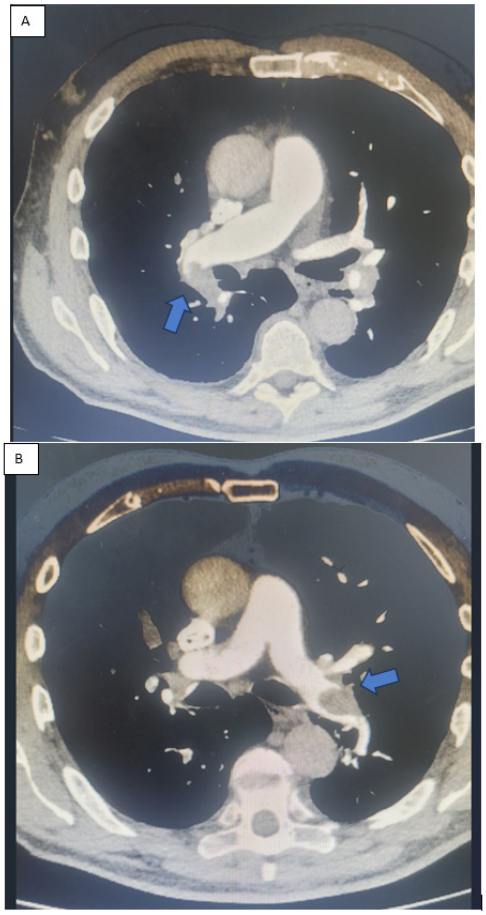

Figure 2: CT pulmonary angiogram scan showing extensive acute bilateral pulmonary emboli **(A)** Left pulmonary arteries. **(B)** Right pulmonary arteries.

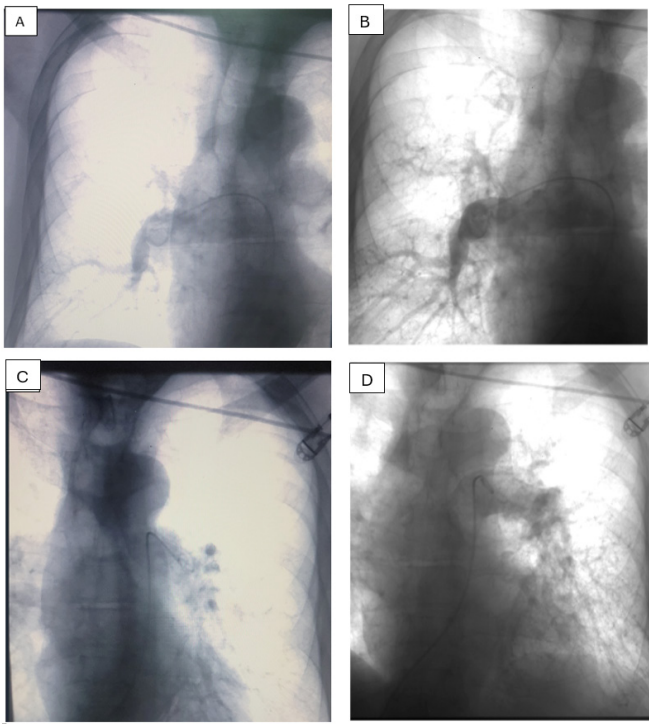

Figure 3: Images of the pulmonary thrombo-aspiration angiogram **(A)** Right pulmonary artery showing the filling defect in the upper lobe segment pre-procedure, **(B)** Right pulmonary artery post-procedure **(C)** Left pulmonary artery showing the filling defect in the main lower lobe segment pre-procedure, **(D)** Left pulmonary artery post-procedure.

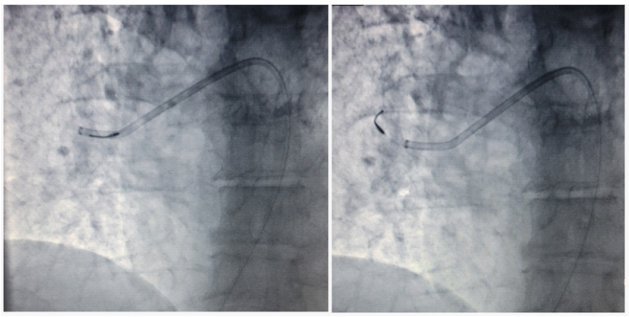

Figure 4: Images showing the Indigo System CAT8 catheter and SEP8 Separator in the right pulmonary artery where the thrombus is being removed.

Discussion

Pulmonary Embolism (PE) occurs when an intramural thrombosis forms within the pulmonary artery, partially or completely obstructing blood flow. It is characterized by high mortality (34% of patients die suddenly after an acute event [1]) and the development of chronic pulmonary hypertension, which leads to deterioration of the quality of life. In severe cases, Right Ventricular (RV) failure can result from acute pressure overload, leading to potentially fatal consequences [1,2]. Given the urgency of this condition, a prompt and comprehensive approach is necessary for diagnosis and treatment in cases of high-risk PE, including immediate diagnostic measures upon suspicion and therapeutic intervention upon confirmation or high suspicion. However, the absence of haemodynamic instability does not exclude RV dysfunction, and thus an elevated PE-related early risk [1].

ECG findings during the acute phase of PE commonly include the $S_1Q_3T_3$ sign (prominent S wave in lead I, Q wave and inverted T wave in lead III), new right bundle branch block either complete or incomplete, rightward shift of the QRS axis, ST- segment elevation in V_1 and aVR, generalized low amplitude of ORS complex, sinus tachycardia, atrial flutter/ fibrillation, atrial premature contractions and T wave inversions in lead V_1 - V_4 [6].

When acute thrombosis is present, D-dimer levels in the plasma increase due to simultaneous activation of coagulation and fibrinolysis. A normal D-dimer level has a high negative predictive value, so acute PE or DVT is unlikely [1]. However, the positive predictive value of elevated D-dimer is low and, therefore would not be useful for confirming PE. Elevated D-dimer can be seen in acute myocardial infarction, severe infection or inflammatory disease, cancer, hospitalized patients and during pregnancy [1]. Acute PE can cause RV pressure overload and increased myocardial stretch, which leads to the release of B-type natriuretic peptide (BNP) and N-terminal (NT)-proBNP [1].

Echocardiographic findings of RV overload and/ or dysfunction are usually suggestive of acute PE [1]. This is demonstrated by:

RV dilation with basal RV/LV ratio > 1.0

Pulmonary ejection acceleration time (measured in the RV overflow tract) <60 ms with a peak systolic tricuspid valve gradient < 60mmHg ('60/60' sign)

Depressed contractility of the RV–free wall compared to the 'echocardiographic' RV apex (McConnell sign)

Flattened intraventricular septum.

Decreased tricuspid annular plane systolic excursion (TAPSE) <16 mm [1].

CT Pulmonary Angiography (CTPA) is the gold standard non-invasive imaging test for detecting venous thromboembolic disease [1].

Current guidelines recommend catheter-based techniques should be considered for patients with high-risk PE who cannot have systemic thrombolysis due to contraindications [1,2]. For the acute-phase treatment of high-risk PE, the first choice, according to current guidelines, is systemic thrombolysis in addition to unfractionated heparin infusion [1]. Primary systemic thrombolysis is not recommended for intermediate or low-risk PE [1]. In cases of PE with high thrombotic burden and worsening haemodynamics, thrombus aspiration should be considered as an option for restoring pulmonary artery circulation [1-3]. This procedure is particularly useful for patients who cannot undergo systemic thrombolysis due to contraindications or those who have already undergone this treatment but with unsatisfactory results. Systemic thrombolysis was associated with higher rates of severe bleeding and intracranial haemorrhage [1,2].

The Indigo Aspiration Catheter (Penumbra) was validated in the EXTRACT-PE (A Prospective, Multicenter Trial to Evaluate the Safety and Efficacy of the Indigo Aspiration System in Acute Pulmonary Embolism) study of patients with haemodynamically stable PE and associated RV dysfunction [4,5]. The trial results showed a significant improvement in RV function, with low rates of mortality and major bleeding, as well as no cardiac injury [4,5]. Prompt intervention reduces mortality which is expected to decrease the risk of haemodynamic collapse [4,5].

The Penumbra Indigo Aspiration System consists of the 8-F Indigo aspiration catheter, tubing, pump and separator [4,5]. Haemodynamics are evaluated through a diagnostic pulmonary angiogram after percutaneous access to the pulmonary artery. The aspiration catheter is positioned proximal to the thrombus after being introduced over a guidewire, either to the left or right pulmonary artery. The separator is advanced through the catheter if required to clear the catheter lumen. Pulmonary vessels could be aspirated repeatedly, and the catheter can be flushed between passes [4,5]. A final pulmonary angiogram and haemodynamic evaluation are conducted after the Indigo device is removed.

It is worth noting that thrombo-aspiration devices have proven to be effective and are being increasingly used in unstable patients, despite the need for large-bore access to venous system [1-3]. It can also be used for deep vein thrombosis and myocardial infarction. Aspiration thrombectomy for PE is a safe and effective option that significantly improves respiratory and haemodynamic parameters in the first 24 hours after the procedure, with a lower complication rate than fibrinolysis [1,3].

Conclusion

This case report provided evidence on the effectiveness and safety of aspiration thrombectomy for high-risk pulmonary embolism.

Abbreviations: PE: Pulmonary Embolism; RVSP: Right Ventricular Systolic Pressure; NOAC: Non-Vitamin K Antagonist Anticoagulant; RV: Right Ventricular; BNP: B-Type Natriuretic Peptide; NT: N- Terminal; TAPSE: Tricuspid Annular Plane Systolic Excursion.

Declarations

Ethics statement: Ethical approval was obtained with reference number CHCMSM4 from Ethics Review Board of Medcorp Limited. Informed consent was obtained from the patient involved in this case report.

Conflict of interest: All authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Authors contribution: CG: responsible for management of the patient & reviewing the manuscript, JM: performing interventional procedure, reviewing/editing the manuscript, SM: conception and drafting/editing of the manuscript, AM: conception and drafting/editing of the manuscript, RR: reviewing/editing the manuscript, GA: reviewing/editing the manuscript.

Funding Statement: No funding was received.

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