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Successful Treatment of Renal Cell Carcinoma Pulmonary Embolism Using Inari FlowTriever System

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Abstract

Pulmonary embolism (PE) is most often a result of deep vein thrombosis (DVT), and rarely occur due to a non-thrombotic source. In this case, a 79-year-old man with known metastatic renal cell carcinoma (RCC), end-stage kidney disease (ESKD) on hemodialysis and a history of 6 hours of car travel presented to the hospital with shortness of breath, weakness, syncopal episodes, and an initial SpO2 of 85% on room air. After positive chest radiographic findings of pulmonary congestion, a subsequent computed tomography angiogram confirmed a large embolus near totally occluding the right main pulmonary artery. Given the RCC and the abnormal presentation of PE, endovascular mechanical embolectomy was performed using the FlowTriever System (Inari Medical). Pulmonary artery patency was restored, and the pressure improved immediately following embolus aspiration. Pathological findings confirmed renal cell carcinoma as the constituent of the embolus. The Inari FlowTriever system can be used to successfully aspirate RCC emboli present in the large pulmonary arteries.

Keywords: Case report; Pulmonary embolism; Renal cell carcinoma; Mechanical embolectomy; Inari; FlowTriever

Introduction

Pulmonary embolism (PE) is a known form of venous thromboembolic (VTE) disease with potentially fatal outcomes [1]. Although the true incidence of VTE may be underreported, the annual incidence is estimated to be 117 per 100,000, and the mortality rate due to PE is estimated to be 100,000 deaths per year in the United States [1]. More than 50% of PEs can be attributed to the presence of a deep vein thrombosis (DVT) in the lower extremity [2]. Additionally, VTE disproportionally affects older patients, and studies have suggested higher incidences in men than in women [1,2]. Virchow's triad of hypercoagulability, endothelial damage, and stasis of blood flow is a known risk factor for VTE.

These risk factors can be either inherited (e.g., factor V Leiden) or acquired (e.g., malignant). However, in rare cases, PE can result from non-thrombotic sources, such as adipose tissue, air, lipids, inorganic matter, or tumors [3-6].

Given that the most common presentation of PE is DVT, the mainstay of treatment includes prompt supplemental oxygen therapy, anticoagulation with heparin, and reperfusion strategies such as thrombolysis. Although these treatments are highly successful for thrombus-based PE when administered in a timely manner, studies have failed to prioritize embolectomy as a treatment option. After risk stratification and determination of PE that originates from a non-thrombotic source, initial management should consider prioritizing embolectomy, especially for tumor-based emboli, rather than immediate anticoagulation. In this regard, catheter-directed therapies have been extensively studied, with significant success rates of up to 87% [7]. Although there is a risk of perforating the pulmonary arteries with catheter-directed embolectomy, this is a very rare complication [7].

In this report, we present a 79-year-old man with several risk factors for VTE, including metastatic renal cell carcinoma, who underwent successful embolectomy with the Inari FlowTriever catheter-directed system as the primary treatment modality for non-thrombotic, tumor-based PE.

Case Presentation

A 79-year-old white man presented to the hospital via emergency medical services (EMS) complaining of shortness of breath, weakness, and syncopal episodes. The EMS reported an SpO2 of 85% on room air. His medical history was significant for metastatic renal cell carcinoma (RCC) and end-stage kidney failure (ESKF) on hemodialysis via a right internal jugular vein tunnel dialysis catheter, type 2 diabetes mellitus, hypertension, hyperlipidemia, and chronic bilateral lower extremity swelling. He had recently traveled in a car for 6hr, 2 days prior to his presentation. Previously, left total nephrectomy and near-total right nephrectomy (with the remaining right RCC) were performed to treat RCC. Hence, chronic hemodialysis via a right internal jugular tunneled dialysis catheter was initiated three weeks before admission.

Physical examination in the emergency department revealed a temperature of 36.7 °C, pulse rate of 93 beats/min, respiratory rate of 18 breaths/min, blood pressure of 94/62 mmHg, and SpO2 of 96% on 2 L/min oxygen via a nasal cannula. The patient was alert, oriented, and had no acute distress. Cardiovascular examination revealed a regular rhythm, normal peripheral perfusion, and 3+ pitting edema in the bilateral lower extremities. Abdominal examination was benign, and edema of the lower extremities was observed. Respiratory examination demonstrated lungs clear to auscultation bilaterally with non-labored respiration. Initial labs included white blood cell count of 15.9x10^3/microliter, red blood cell count 1.82x10^6/microliter, hemoglobin 7.1 grams/deciliter, hematocrit 22.3%, and creatinine 7.9 milligram/deciliter. Chest radiography showed bilateral pulmonary metastatic disease with small bilateral pleural effusions and bibasilar atelectasis, in addition to pulmonary venous congestion.

Empiric intravenous vancomycin and cefepime were initiated for suspected underlying pneumonia due to an elevated white blood cell count. Additionally, blood transfusion was performed to treat anemia. Computed tomography angiography (CTA) of the chest revealed no evidence of consolidations or infiltrates, suggesting pneumonia. However, a large pulmonary embolus completely occluding the right main pulmonary artery was identified (Figure 1), in addition to a small-to-moderate burden of segmental and subsegmental pulmonary emboli in the left lower lobe. Right ventricular (RV) dysfunction was indicated by an N-terminal prohormone of brain natriuretic peptide (NT-proBNP) level of 44,934 pg/mL and an RV/LV ratio of 1.2. Empiric antibiotics were discontinued, and continuous heparin infusion was initiated.

Figure 1: Transverse CTA of the chest demonstrating filling defect of the right pulmonary artery consistent with near total occlusion indicates acute PE (red arrows).

Bilateral Doppler ultrasound (US) of the lower extremities revealed no evidence of deep vein thrombosis (DVT). The patient was admitted to the ICU. Given the abnormal visual presentation of PE on CTA and a history of metastatic RCC, endovascular mechanical embolectomy was performed using the FlowTriever System (Inari Medical) (Figure 2). The right common femoral vein was used for access. Additionally, the inferior venacavogram demonstrated a mildly dilated IVC with a filling defect along the right lateral wall near spinal level L2 (Figure 3). Pulmonary angiography was used to position the FlowTriever system at the embolus and confirm its clearance after aspiration (Figure 4,5). Immediately after embolus aspiration, the pulmonary artery pressure improved from 54/18 mmHg to 34/12 mmHg.

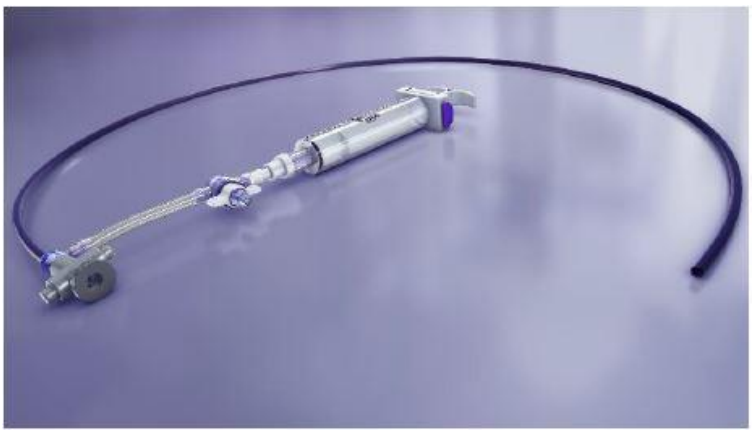

Figure 2: Schematic image of Inari FlowTriever system

Figure 3: IVC filling defect near L2 (black arrow).

Figure 4: Pre-embolectomy pulmonary angiogram with obstruction (black arrows).

Figure 5: Post-embolectomy pulmonary angiogram with return of blood flow (black arrows).

Upon gross examination, the aspirated emboli appeared stringy and fibrous, with minimal clotting. A sample was sent for pathological examination, which confirmed clear cell renal carcinoma with histology positive for pankeratin, CAM 5.2, and PAX8 (Figure 6).

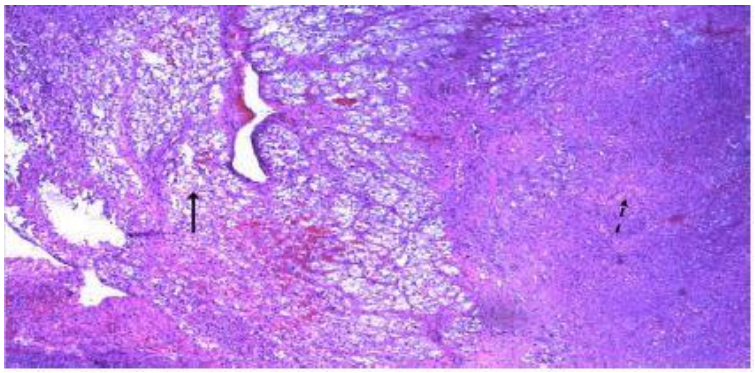

Figure 6: Histological findings of the embolus revealing viable clear cell renal cell carcinoma (solid arrow) and a mixture of necrotic tumor cells, fibrin, and necrotic inflammatory cells (dashed arrow) 4x view.

The patient recovered well, with stable oxygen saturation, resolution of shortness of breath, and no hemoptysis. The patient was started on apixaban 5 milligrams twice a day for lifelong anticoagulation. The patient was then discharged to continue chronic hemodialysis. The patient's discharge instructions included follow up with oncology to begin outpatient chemotherapy as soon as possible. Patient advised to follow up with nephrology and primary care physician within a week of discharge.

Discussion

To our knowledge, this is the first case report of embolectomy in which the Inari FlowTriever system was used to successfully remove a non-thrombotic, renal cell carcinoma tumor-based PE. Our patient presented with many risk factors for VTE and signs of DVT and PE, including low oxygen saturation, dyspnea, malignancy, chronic bilateral lower extremity edema, syncopal episodes, and recent long travel. However, the characteristics of DVT and PE are not necessarily specific. Blood and imaging tests were performed to rule out possible pneumonia and, following the diagnosis of PE, risk stratification was performed to determine the treatment plan [8].

Previous studies, such as the PIOPED study, demonstrated that clinical assessment combined with ventilation/perfusion scans provided limited risk stratification for PE patients [9]. Current guidelines have improved patient risk stratification by assessing clinical parameters such as the simplified Pulmonary Embolism Severity Index (sPESI $\geq$ 1), elevated biomarkers (e.g., troponin and NT-proBNP), signs of RV dysfunction on CTA (e.g., RV/LV ratio), and hemodynamic instability. These factors help identify normotensive patients who show signs of right heart strain and are at the highest risk of decompensation and death. Conventional treatment modalities, such as anticoagulation plus monitoring for low-risk patients or systemic lytic therapy for higher-risk patients, continue to have widespread use with supportive evidence.

Interventional therapeutic approaches have been developed to reduce significant bleeding risks and long-term sequelae associated with these approaches in intermediate-and high-risk patients. For these patients, current guidelines recommend the initial use of anticoagulation prior to diagnostic imaging, followed by the use of systemic thrombolytic therapy, catheter-directed thrombolytic therapy, or embolectomy after confirmation of PE on diagnostic imaging [10].

The present case report demonstrates the importance of considering the source of PE when selecting treatment strategies. The patient experienced intermediate-high-risk PE in the context of known RCC that was both locally invasive and metastatic. Current guidelines suggest the use of catheter-directed treatment in these patients only after a contraindication or failure of systemic thrombolytics. However, it is important to consider the need to treat potentially non-thrombotic emboli, particularly in RCC, where there is a higher risk of embolism [11] resulting from either thrombotic or tumor sources [12].

Except for embolectomy, treatment modalities of PE usually target thromboembolisms. This is appropriate because the most common composition of PE is a thrombus [1]. However, clinical scenarios, such as in the case of this patient or those including chronic clot (>14 days) composed of collagen rather than fibrin, necessitate prioritizing the use of embolectomy, which can treat both thrombotic and non-thrombotic emboli. Tafur et al., in a meta-analysis in 2017, found catheter-directed treatment for PEs to be successful [7]. Although catheter-directed therapies carry an inherent risk of perforation, the clinical evidence did not prove worse outcomes for catheter-directed treatment than for ultrasound [7]. A recent case study also demonstrated the effectiveness of the Inari FlowTriever system's ability to treat an acute-intermediate PE with minimal blood loss. They found the FlowTriever system provided immediate improvement of RA pressures following evacuation of thrombus, relieved the patient's shortness of breath, and improved oxygen saturation. This is in comparison to traditional treatment with thrombolytics which can take hours to provide relief of shortness of breath and improved oxygenation [13].

While this case did not require an IVC filter, the source of such embolus warrants suprarenal IVC filter placement. This approach has been shown to prevent PEs originating in the renal veins, with no increased risk of complications compared with typical infrarenal placement [14,15].

Conclusion

This report presents a case of locally invasive and metastatic RCC resulting in an abnormal presentation of higher-risk PE, which was successfully corrected with embolectomy as the primary treatment option. As evidence accumulates to support interventions for complex PEs, it is imperative for guidelines to consider the necessity of prioritizing embolectomy for non-classic PEs with regard to their size, location, and composition.

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