



# First Ultrasound-Assisted Thrombolysis for Pulmonary Embolism after Lung Surgery

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Thorac Cardiovasc Surg Rep 2023;12:e14–e16.

## Abstract

### Keywords

- pulmonary embolism
- lung cancer treatment (surgery, medical)
- thoracic surgery

**Background** Experience with early postoperative catheter-directed ultrasound-assisted thrombolysis (USAT) in high-risk pulmonary embolism (PE) is limited. A first case of USAT directly after pulmonary surgery is presented.

**Case Description** A 60-year-old female patient with two malignancies (triple negative breast cancer and pulmonary squamous cell carcinoma) underwent video-assisted lobectomy. The second postoperative day, she developed PE with hemodynamic deterioration. Note that 24 mg of alteplase was applied by USAT. After 3 days she was successfully weaned from ventilation and vasopressors.

**Conclusion** USAT for acute PE is possible after major pulmonary resections and seems promising if reperfusion is needed.

## Introduction

Thirty-day mortality of patients who developed venous thromboembolism or pulmonary embolism (PE) after lung cancer surgery is approximately 5%.<sup>1</sup> This can be explained by preexistent and surgically induced reduction of lung function and pulmonary vasculature. Furthermore, general thoracic patients often are in a fragile medical condition with cardiac and other comorbidities.

Acute right heart failure (RHF) is the most frightened complication of PE and is caused within minutes by pressure overload. These patients have a 2.4- to 3.5-fold increase in mortality compared with those without acute RHF.<sup>2</sup> Multiple prognostic models are available to classify mortality risk such as the (simplified) Pulmonary Embolism Severity Index (sPESI and PESI) which stratifies patients by clinical parameters.<sup>3</sup>

Ultrasound-assisted thrombolysis (USAT) with EkoSonic endovascular system (Boston Scientific Corporation, Marlborough, Massachusetts, United States) is a relatively novel catheter-based reperfusion technique that can be used in PE patients at high risk for complications with systemic thrombolysis.<sup>4</sup> Kucher et al reported that USAT was superior to heparin alone in reversing right ventricle (RV) dilatation without an increase in bleeding complications in intermediate-risk PE patients.<sup>5</sup> In the very particular setting of high-risk PE directly after major lung resections, systemic thrombolysis is usually contraindicated. Nevertheless, USAT enables fast recovery of RV function and could be a convenient alternative to systemic thrombolysis, but experience is lacking.

Here, we report a clinical case of a female patient with breast cancer and pulmonary squamous cell carcinoma who developed PE after video-assisted lobectomy and was successfully treated with USAT despite pulmonary surgery the day before.

received  
October 17, 2022  
accepted after revision  
December 3, 2022

DOI <https://doi.org/10.1055/s-0043-1762551>.  
ISSN 2194-7635.

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## Case Description

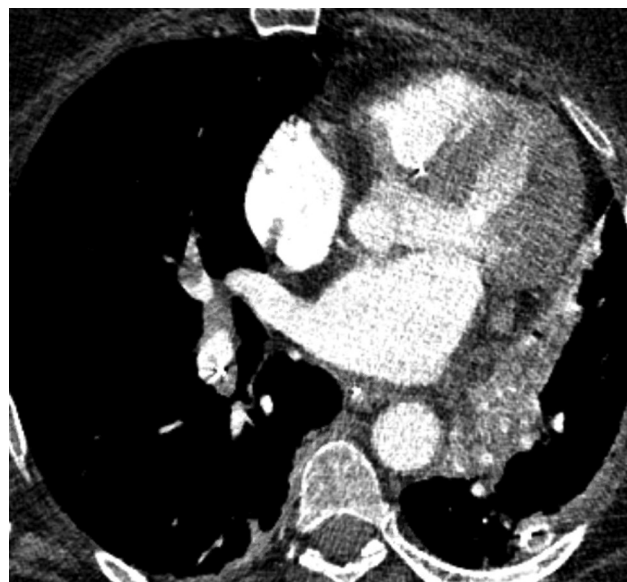
In 2020, a 60-year-old female patient was transferred to our thoracic department after diagnosis of breast cancer with a second nonsmall cell lung carcinoma (NSCLC) in the left upper lobe. Comorbidities included obesity, asthma, chronic obstructive pulmonary disease, hypertension, and active smoking with 40-pack years.

The staging revealed a right-sided triple-negative breast cancer without lymph node metastasis. Endobronchial ultrasound of mediastinal lymph nodes was also negative, but transbronchial needle aspiration revealed a second primary squamous NSCLC of the left upper lobe. Brain metastasis was excluded by magnetic resonance imaging scan. Resection of the left upper lobe for NSCLC before chemotherapy for breast cancer was indicated in a multidisciplinary tumor board.

The patient underwent uncomplicated minimally invasive (left upper) lobectomy and mediastinal lymphadenectomy in the setting of standard video-assisted thoracic surgery with three ports. The final histopathological diagnosis confirmed the diagnosis and showed a barely differentiated squamous cell carcinoma (G3, pT2a, pN0) according to the staging system by the Union for International Cancer Control. The patient returned to standard postoperative care and only slight hoarseness as a possible sign of recurrent nerve paralysis was recognized. On the second postoperative day, the patient developed syncope, dyspnea, and decrease of saturation to 73%. A computed tomography (CT) scan revealed a large right-sided PE including the right upper and middle pulmonary arteries, with additional thrombotic material in the right lower pulmonary artery (→Fig. 1). Additionally, we observed impaired RV function and elevated brain natriuretic peptide of 299 pg/mL.

Cardiopulmonary function rapidly decreased, and the patient was transported to the intensive care unit (ICU) for invasive ventilation and therapeutic vasopressors. According to the PESI, the patient was classified as high-risk patient (class 4 with 4–11% risk of 30-day mortality) due to age, history of cancer, and decreased O<sub>2</sub> saturation (73%). Therefore, a multidisciplinary Pulmonary Embolism Response Team decision was made for EKOS reperfusion therapy.

On the same day, the patient was transferred to the operation room for catheter placement and immediate initiation of local right-sided USAT reperfusion. Afterwards the patient stabilized, and the use of vasopressors could be reduced. CT scan evaluation of the PE after 2 days revealed good positioning of the EKOS catheter in the right pulmonary branch and regress in PE material (→Fig. 2). EKOS reperfusion was applied for 3 days and the total amount of administered alteplase was 24 mg. RV function normalized, and we observed no bleeding complications. Four days after PE, the patient was successfully extubated. The total ICU time was 12 days due to delirium and the patient was transferred to the general ward of a local hospital for further recovery and planning of neoadjuvant chemotherapy for breast cancer. Prophylactic anticoagulation with factor Xa inhibitor apixaban was prescribed. Consultation with the attending on-



**Fig. 1** Computed tomography (CT) scan with contrast showing predominantly right-sided pulmonary embolism and a left-sided status with post-upper lobe lobectomy.



**Fig. 2** Computed tomography (CT) scan with contrast showing good positioning of the EKOS catheter in the (lower) right pulmonary artery branch and regression of pulmonary embolism after 2 days.

cologist was conducted 6 months after discharge. The patient was alive, received chemotherapy, had no residual complaints of PE, and no evidence for recurrent nerve paralysis. Neoadjuvant chemotherapy for breast cancer was planned and given in her local hospital. Follow-up after 12 months showed no adverse signs or recurrence of malignancy.

## Discussion

Although literature on USAT for PE after surgery is scarce, our team has some experience in the use of EKOS in postsurgical

patients.<sup>6</sup> In these cases, low-dose USAT appeared to be a safe and reasonable therapy for early postoperative PE. Retrospective analysis with small sample sizes reported controversial clinical outcomes between USAT and other catheter-directed modalities.<sup>7,8</sup> We still use USAT because this is the technique that is best supported by clinical trial data.<sup>5,9</sup>

Special about our case is that patients after lung resection for malignancy suffer from already compromised pulmonary reserve and critical medical condition. Therefore, PE is an independent marker of poor outcome in this specific patient group.<sup>10</sup> Reduction of pulmonary reserve depends on the extent of lung resection and can range from small wedge resections up to pneumectomies. The latter is associated with more advanced disease and higher mortality. Our case comprised a left upper lobectomy which leaves higher pulmonary reserve than a pneumectomy. However, thrombolysis with USAT was given directly into pulmonary circulation despite previous lung surgery and literature on this specific case is very scarce.

Apart from rare reports on systemic thrombolysis for PE after lung resection surgery, Lee et al described a case with PE 6 weeks after pneumectomy that was managed with catheter-directed thrombolysis.<sup>11</sup> Major differences to our case are that PE was found in the very late postoperative period, catheter-directed thrombolysis was not administered into the same side of the lung that needed surgery, and we used USAT with EKOS instead of solely catheter-directed thrombolysis.

To the best of our knowledge, this is the first case demonstrating that USAT is feasible in acute PE directly after lobectomy with reduced pulmonary reserve. Together with previous cases from our clinic,<sup>6</sup> we conclude that USAT might be the most favorable approach in postoperative patients with high-risk PE even when administered directly into pulmonary circulation after lung surgery.

#### Authors' Contribution

AK and SK were directly involved in treatment of this clinical case, KS and KD obtained patient data, KS and KD wrote the first version of the manuscript, all authors critically revised the manuscript.

#### Note

This case report study was approved by the independent medical ethics committee and written informed consent was obtained by the patient.

#### Conflict of Interest

There is no conflict of interest to declare from any of the authors.

#### Acknowledgments

We acknowledge and thank Dr. Thorsten Winters from the Marienhospital Aachen (Germany) for further information and cooperation regarding the patient.

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