

## TECHNICAL NOTE

# Video-assisted thoracoscopic surgery in the treatment of non-small-cell lung cancer complicated with left atrial tumor thrombus

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## Keywords

Atriotomy; non-small-cell lung cancer; tumor thrombus; video-assisted thoracoscopic surgery.

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## Introduction

Although it is quite rare, there are several reports of locally advanced non-small-cell lung cancers macroscopically growing into the left atrium.<sup>1–3</sup> In order to reduce the risk of sudden death as a result of cardiac failure or systemic embolization, simultaneous removal of the left atrial tumor thrombus and lung cancer might improve prognosis in selected cases. Traditional open surgical interventions for these cases with or without cardiopulmonary bypass are still controversial and challenging. We present a case of pulmonary squamous cell carcinoma complicated with left atrial tumor thrombus. After careful preoperative evaluation of the tumor thrombus through ultrasonic cardiogram, the patient was successfully treated with complete video-assisted thoracoscopic lobectomy and atriotomy with cardiopulmonary bypass standby.

## Case report

A 53-year-old man had suffered from a cough and chest distress for a period of about one month. The patient was otherwise asymptomatic, his smoking history was one pack/day for

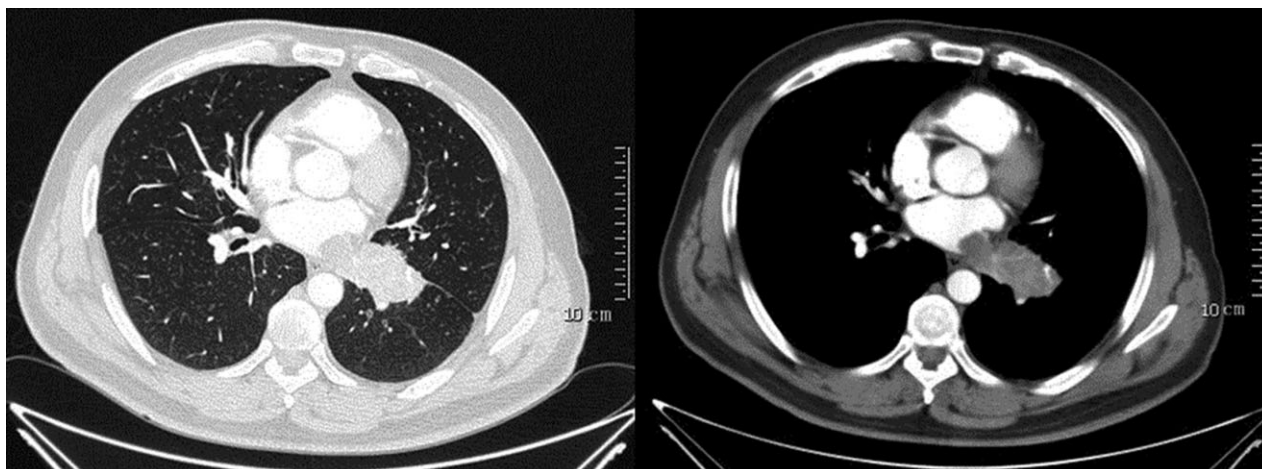
## Abstract

We report a case of pulmonary squamous cell carcinoma complicated with a tumor thrombus in the left atrium. The left atrial tumor thrombus, together with the left lower lobe, was removed via complete video-assisted thoracoscopic surgery (VATS), with cardiopulmonary bypass standby. The patient recovered well from surgery, received four cycles of postoperative chemotherapy, and is now under follow-up at the outpatient clinic. Although the optimal treatment is still controversial, simultaneous VATS and atriotomy under the premise of preoperative evaluation of the thrombus, including size and extent, might prevent systemic embolization and sudden death, alleviate the wound, promote postoperative rehabilitation, and improve prognosis in selected patients.

30 years, and he had quit smoking at age 51. His physical examination was unremarkable. Chest radiography showed an abnormal shadow in the left lower lung field. Enhanced chest computed tomography (CT) revealed an approximate 7 cm × 3 cm mass with an irregular border centered in the hilar region of the left lower lobe, with a tumor thrombus extending from the left inferior pulmonary vein into the left atrium. No enlarged mediastinal lymph nodes were found (Fig 1).

A preoperative ultrasonic cardiogram was performed to evaluate the status of atrial invasion. It was confirmed that the lesion was adjoined to the side wall of the atrium, adjacent to the left inferior pulmonary vein, protruding into the left atrium about 1.5 cm. Positron emission tomography (PET)-CT indicated no fluorodeoxyglucose uptake in the mediastinal lymph nodes or other organs. Bronchoscopy with endobronchial biopsy demonstrated a low-grade squamous cell carcinoma of the left lower lobe (Fig 2).

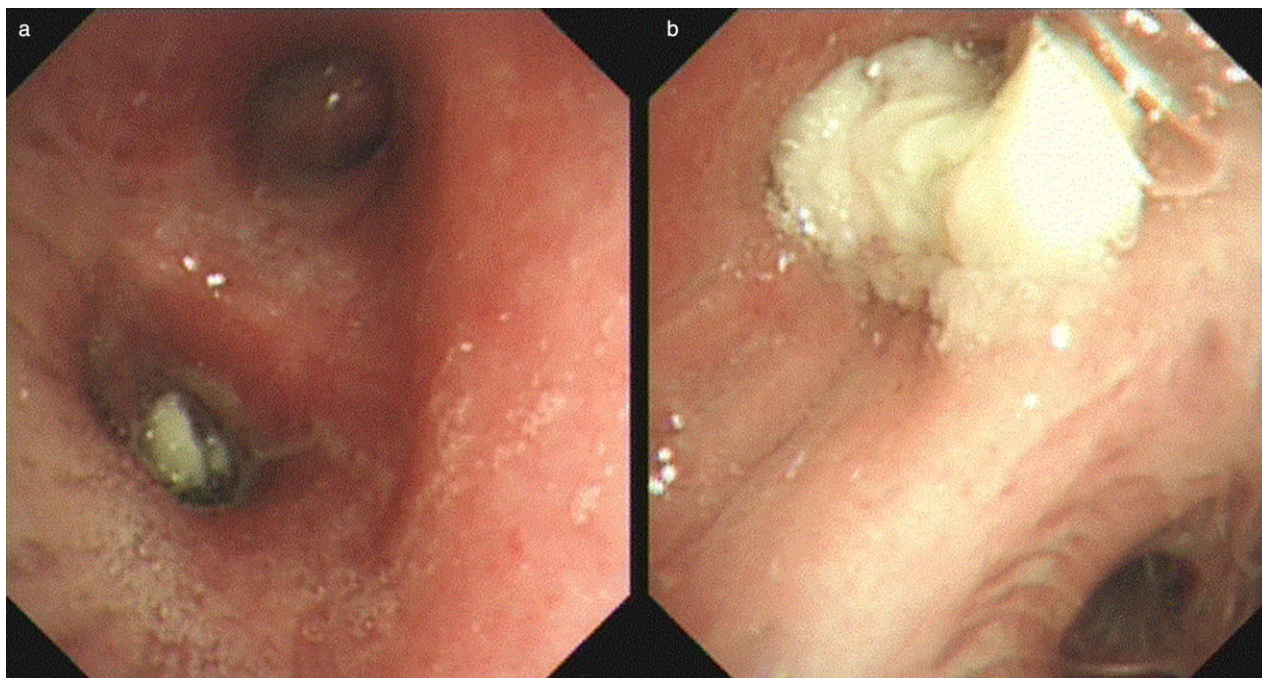
The patient was staged as cT4N0M0 stage IIIA. He received two cycles of neoadjuvant chemotherapy with gemcitabine and cisplatin (75 mg/m<sup>2</sup> cisplatin on day 1; 1250 mg/m<sup>2</sup> gemcitabine on days 1, 8, and every 21 days), which was well tolerated. Re-examination of the enhanced chest CT scan



**Figure 1** Enhanced thoracic computed tomography CT scan showing a mass centered in the hilar region with a tumor thrombus extending to the left atrium.

showed no obvious change in tumor size and extent; the tumor was assessed as “stable” according to Response Evaluation Criteria in Solid Tumors. The benefits and risks of complete resection were thoroughly explained to both the patient and his relatives. After careful consideration and thoughtful preparation, a video-assisted thoracoscopic left lower lobe resection, systemic mediastinal lymph node dissection and atriotomy was performed, with cardiopulmonary bypass standby.

Intraoperatively, conventional three port video-assisted thoracoscopic surgery (VATS) was adopted. A 1 cm incision at the level of the seventh intercostal space (ICS) at the median axillary line was applied for the camera port, a 6 cm incision at the level of the fourth ICS at the anterior axillary line was applied for a working port, and a 1.5 cm incision at the level of the eighth ICS at the posterior axillary line was applied for an auxiliary operating port. Under the surveillance of a thoracoscope, the tumor was found to be located



**Figure 2** Bronchoscopy showing a mass in the left lower lobe bronchus. Squamous cell carcinoma was diagnosed by bronchoscopic biopsy. (a) Left main bronchus; (b) bronchus of left lower lobe.

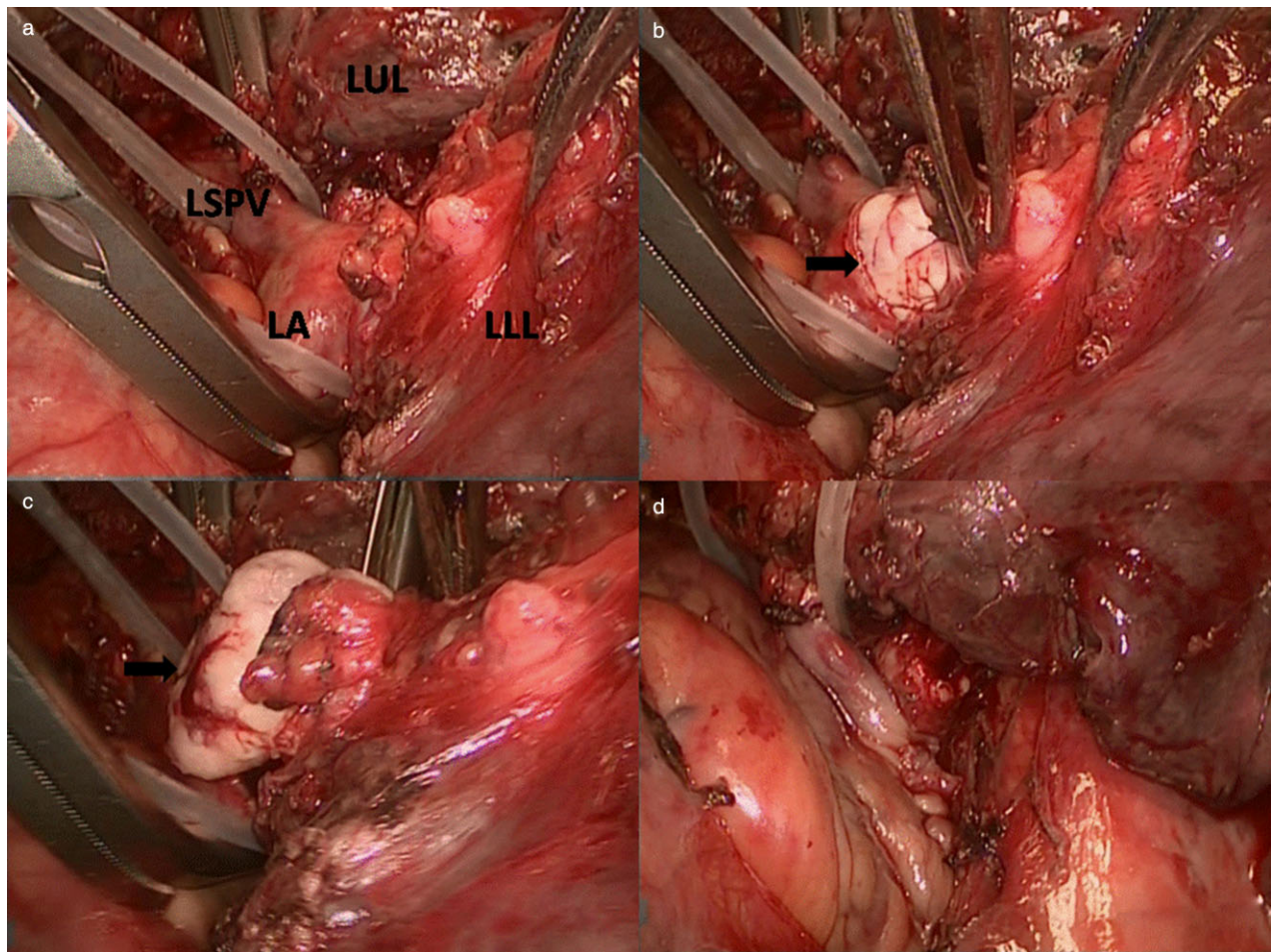


in the lumen of the left lower lobe, tending to invade proximally along the left inferior pulmonary vein into the atrium. Pulmonary arterial branches of the left lower lobe were divided and clamped with forceps or staplers and the bronchus was stitched manually on the premise of the negative bronchial margin condition. After the incision of the pericardium, it was confirmed that the tumor thrombus merely invaded the junction of the left inferior pulmonary vein and the left atrium. The left atrium was then clamped by auricular clamp, noting that the position of the clamp should not cross the interatrial sulcus. After reconfirmation that the tumor thrombus was completely located at the distal end, no arrhythmia occurred during the pause, which lasted one minute. A longitudinal left atriotomy was then performed and a yellowish fragile tumor thrombus, approximately  $3.5 \times 2.0$  cm in size, was noted. The left atrial wall was free from invasion, confirmed by fast frozen pathology. The

tumor thrombus, together with the left lower lobe, was removed. The defect in the left atrium was closed using a running 4/0 polypropylene suture (Fig 3). Systemic mediastinal lymph node dissection was then carried out. The operation took a total of 260 minutes, the blood loss volume was about 200 mL, and no blood transfusion was required.

Pathological analysis revealed squamous cell carcinoma of the left lower lobe with cancerous thrombus formation in the left inferior pulmonary vein and left atrium. Both the bronchial and venous margins were negative. Metastatic lymph nodes were detected in the 11th station (2/8). The patient was diagnosed as pT4N1M0 stage IIIA.

The patient's postoperative course was uneventful. He recovered well and was discharged on the ninth postoperative day. He received four cycles of postoperative chemotherapy with docetaxel and cisplatin ( $75 \text{ mg/m}^2$  cisplatin on day 1;



**Figure 3** Intraoperative illustrations. (a) Brief view and position of the tumor thrombus before resection. (b) After incision of the left atrium, the tumor thrombus was exposed. (c) The tumor thrombus was completely exposed, with no infiltration to the left atrial or vessel wall. (d) After removal of the tumor thrombus, together with the left lower lobe, the left atrium was closed using a running suture. Dark arrow demonstrates the tumor thrombus in the pulmonary vein and left atrium. LA, left atrium; LLL left lower lobe; LSPV left superior pulmonary vein; LUL left upper lobe.

75 mg/m<sup>2</sup> docetaxel on day 1 and every 21 days), which was well tolerated. Prophylactic whole brain irradiation was recommended, but the patient refused. For the 16 months to date since surgery, the patient has remained free from recurrence, and is now being followed-up at the outpatient clinic.

## Discussion

Non-small-cell lung cancer involving the left atrium is classified as T4, regardless of the degree and extent of infiltration. T4N0-1M0 cases are classified as stage IIIA, while T4N2M0 cases are classified as stage IIIB according to the 7th tumor node metastasis classification.<sup>4</sup> There may be either direct invasion of the tumor into the left atrial wall or expansion into the left atrial cavity through the pulmonary veins. The differences in anatomy and histology might have an impact on prognosis. While T4 tumors with direct atrial extension are considered inoperable, there may be exceptions for selected patients. If the tumor or tumor thrombus extends in “limited” space (such as the cavity of the pulmonary vein) only, without infiltration to the pericardium, blood vessel wall, or cardiac muscle, complete resection may significantly prolong survival time and improve quality of life on the premise of negative bronchial and vascular margin conditions.<sup>5</sup> The present method of clinical staging may not reflect the particularity of such cases; therefore, a more reasonable T staging is required, based on future survival analysis with a larger sample size.

In general, there are two types of VATS procedures: complete and hybrid. To the best of our knowledge, there has been no previous report of complete VATS in the treatment of NSCLC complicated with tumor thrombus. The well-known advantages of VATS include less trauma and pain, shorter chest drainage duration, decreased hospital stay, and preservation of short-term pulmonary function. In more specific cases, such as those with tumor thrombus, conventional thoracotomy is commonly adopted and technically sufficient. In recent years, the indication of VATS has been reasonably expanded. With the improvement of surgical techniques, VATS might provide additional assistance compared with conventional thoracotomy. Thoracoscopic exploration may facilitate early detection in cases of locally advanced lung cancer with tumor thrombus complicated by micro-metastasis to the visceral or parietal pleura, thus, avoiding open-chest exploratory surgery. In addition, surgeons might obtain a more accurate judgement of the degree and extent of the tumor thrombus with the help of VATS, thus, significantly avoiding repeated palpation and reducing the risk of tumor thrombus shedding into systemic circulation, causing stroke or other end-organ dysfunction. It should be noted that we moderately extended the length of the operating port to 6 cm, and adopted the auxiliary port to accommodate more surgi-

cal instruments. Enough space was vacated so as to ensure a relatively fixed position for the blocking forceps, which might help to ensure the safety of the operation and facilitate removal of the specimen.

As discussed previously, simultaneous cardiac and lung cancer surgery can safely be performed in selected patients. A partial left atriotomy may be possible if there is limited involvement of the left atrium, but standard surgical feasibility criteria for these patients have not been established. The indications for cardiopulmonary bypass require full consideration. Although some cardio-thoracic surgeons encourage the application of cardiopulmonary bypass in extended pulmonary resections to achieve complete resection or reduce the risk of clamp dislocation, others believe that unplanned or emergency placement of cardiopulmonary bypass may result in a higher mortality rate and a negative prognostic impact on patients with advanced lung cancer.<sup>5–7</sup> Yet venoarterial extracorporeal membrane oxygenation support has been introduced as a safe alternative to cardiopulmonary bypass for advanced general thoracic operations in recent years.<sup>8</sup>

Tumor thrombus shedding is one of the most serious complications of such cases. Schreffler *et al.* reported a case of simultaneous acute bilateral lower limb ischemia, and bilateral renal, splenic, and cerebral infarction as a result of multiple emboli originating from a primary lung malignancy invasion of the left atrium.<sup>9</sup> Considering the risk of systemic embolization, mitral obstruction, or sudden death as a result of tumor thrombus shedding, to ensure the complete resection of tumor thrombus, comprehensive preoperative preparation and meticulous intraoperative surgery need to be particularly emphasized. Preoperative echocardiography, CT pulmonary angiography, as well as cardiac dynamic magnetic resonance and intraoperative transesophageal echocardiography should be performed whenever possible.<sup>10,11</sup> Gentle manual surgery is required, while VATS is strongly recommended. Intraoperative or postoperative arrhythmias associated with atriotomy occurred in approximately one third of these patients, suggesting that prophylactic treatment would be reasonable when atriotomy is anticipated.<sup>12</sup>

In general, surgery is the first choice for the treatment of lung cancer with tumor thrombus; however, multidisciplinary treatment is needed to improve prognosis. As well as postoperative adjuvant chemotherapy, the use of induction chemotherapy considering patient age and performance status may be an ideal choice and an important test for the biology of the tumor. Prophylactic whole brain irradiation might be helpful for controlling brain metastasis resulting from systemic tumor cell seeding from the tumor thrombus.<sup>13</sup> Whether induction chemotherapy or prophylactic whole brain irradiation lead to better survival needs further discussion.

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## Disclosure

No authors report any conflict of interest.

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