Left sleeve pneumonectomy via uniportal video-assisted thoracoscopic approach

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Abstract
Left sleeve pneumonectomy is a rarer intervention compared with right sleeve pneumonectomy. It is a challenging surgical therapeutic strategy even when performed through open thoracotomy. Here, we report a case of uniportal video-assisted thoracoscopic surgery (VATS) left sleeve pneumonectomy in a patient with non-small cell lung cancer. The tumor, located at the opening of left upper lobe bronchus, submucosally invaded the orifice of lower lobe extending upward to 4 to 5 cartilage rings of the left main bronchus and to the level of the carina. Left sleeve pneumonectomy and airway reconstruction was performed through video-assisted thoracoscopic completely with an incision of 4 cm. The total operative time was 220 minutes and the estimated intraoperative blood loss was 300 mL. Chylothorax occurred after surgery, which was well handled, and no other severe complication was observed. Three months after the surgery, the follow-up bronchoscopy revealed good healing of the anastomosis. No signal of tumor recurrence was observed by follow-up examination 1 year after the surgery. To our knowledge, this is the first reported uniportal VATS left sleeve pneumonectomy in the world. It was indicated that uniportal VATS might be a feasible approach for left sleeve pneumonectomy, with less surgical trauma compared with other approaches.

KEYWORDS
airway reconstruction, sleeve pneumonectomy, uniportal video-assisted thoracoscopic

INTRODUCTION
Sleeve pneumonectomy is a challenging surgical therapeutic strategy even when performed under open thoracotomy.1 Left sleeve pneumonectomy is rarer compared with right sleeve pneumonectomy, because of the complexity of anatomy and significant technical difficulties.2,3 We have described detailed surgical technique of uniportal video-assisted thoracoscopic surgery (VATS) right sleeve pneumonectomy before.4 However, no left sleeve pneumonectomy through VATS only has been described.

CASE PRESENTATION
A 63-year-old man was referred to our hospital for sputum with blood for 1 month. Enhanced chest computed tomography (CT) showed a 5.2 × 4.6 cm diameter mass in left upper lobe nearing the hilum, obstructing the left main bronchus and invading the anterior trunk of apical and anterior segment. Bronchoscopy revealed bronchiostenosis caused by a diffusely growing neoplasm in the opening of left upper lobe, invading the orifice of lower lobe, submucosally extending upward to 4 to 5 cartilage rings of the left main bronchus and to the level of the carina (Figure 1). The biopsy pathology results of the neoplasm were squamous cell carcinoma and the result of the left main bronchus was heterogeneous cells.

Surgical technique
The patient was anesthetized with total intravenous anesthesia technique. A right-sided double-lumen endotracheal tube...
was placed for right lung ventilation. The patient was placed in right lateral decubitus position. A 4-cm incision was made in the fourth intercostal space along the left anterior axillary line for camera and all the operative instruments.

First, the mediastinal pleura was opened and the mediastinal structure was inspected to evaluate the mobility of the tumor and the possibility of radical resection. No tumor infiltration into the left recurrent laryngeal nerve, esophagus, or descending aorta was observed.

After that, the left pulmonary artery, superior- and the inferior-pulmonary veins were divided inside the pericardium with a 45 mm white reload EndoGIA (Covidien Medtronic) stapler. Next, the left main bronchus was divided near its opening circumferentially by scissors, and the left lung was removed in a protective bag.

Four traction sutures of 3-0 Prolene (Ethicon) were placed, one on the distal trachea, another three on the posterior and anterior walls of the right main bronchus, respectively, to improve the exposure of distal trachea and the right main bronchus. Thereafter, the tracheal intubation tube was pulled back in the trachea to enable the circumferential dissection of the right main bronchus at its orifice. The carina was removed after dissecting the trachea at one ring above the carina (Figure 2). Proximal and distal margins were confirmed to be negative by intraoperative frozen section.

An end-to-end anastomosis was performed by running sutures with two needles 3-0 Prolene in a clockwise direction, with a spacing of 2–3 mm. After applying several sutures at the posterior part of the anastomosis, the rest of the anastomosis was completed in the opposite direction. Last, the stitches were tightened gradually from back to front and tied. During this process, a 5 L/min high-frequency jet ventilation was introduced to the right main bronchus through the right-sided double-lumen endotracheal tube for ventilation. Significantly, the diameter discrepancy between trachea and bronchus was managed by telescoping the right main bronchus into the trachea to avoid air leakage.

After confirming no air leakage under water, a part of the pericardium was moved to avoid cardiac incarceration and was used to wrap the anastomosis. Please find more details in Surgery Video from Supporting Information.

**Surgical outcome**

The total operative time was 220 minutes with 65 minutes for airway reconstruction. The estimated
Intraoperative blood loss was 300 mL. A chylothorax complication occurred after surgery and lymphangiogram and thoracic duct embolization were performed. On the postoperative day 20, the drainage volume was reduced to <200 mL, and the thoracic drainage tube was removed.

The final diagnosis was squamous cell carcinoma of the tumor (T3N1M0, IIIA, IASLC 8 edition) with a negative FIGURE 2 Surgical techniques. (a) The view of left hilum after dividing left pulmonary vessels. (b) Cutting off the left main bronchus by scissors. (c) The view of left hilum after left pneumonectomy. (d) Four traction sutures placed on the distal trachea and the right main bronchus. (e) Cutting off the right main bronchus at its orifice by scissors. (f) Dissecting the trachea at one ring above the carina. (g) The tube used for high frequency ventilation was sending into the right main bronchus for ventilation after complete resection of the carina. End-to-end anastomosis between remnant trachea and the right bronchus was performed with running sutures. (h) The view of completed anastomosis. LMB, left main bronchus; PA, pulmonary artery; RMB, right main bronchus; SPV, superior pulmonary vein.
result for the surgical margins and lymph nodes except hilar nodes (10) and interlobar nodes (11). Three months after the surgery, the follow-up bronchoscopy revealed good healing of the anastomosis (Figure 3). No signal of tumor recurrence was observed by follow-up examination 1 year after the surgery.

DISCUSSION

Several cornerstones determine the success of the operation. First, accurate patient selection. In this case, the major part of the tumor located in left upper lobe and the tumor submucosally extending upward to 4 to 5 cartilage rings of the left main bronchus and to the level of the carina, without invading the surrounding structure, such as tracheal and aorta, which enabled clearly dividing and anastomosis through VATS. Second, is the sufficient exposure of trachea, carina and right main bronchus. Entirely dissecting the lymph nodes around the trachea and primary bronchus, transecting arterial ligament, and transecting pulmonary vessels inside the pericardium, and positioning traction sutures on trachea and right main bronchus are major actions. Third, excellent surgical especially suture skills. It is the surgeon’s abundant suture experience that is relied on to confirm the needle insertion site when passing through the right lateral wall and posterior wall of trachea. Last, but not the least, close collaboration within the operator, anesthesiologist, operative assistant, and camera holder during the operation. Difficult dissection and anastomosis of the posterior wall, intermittent endotracheal intubation were time consuming and accounted majorly for the anastomosis time of >1 hour, which is comparable with the average time in our recent reported series. Additionally, extracorporeal support and careful perioperative management remain indispensable to avoid postoperative respiratory complications and perioperative morbidity.

In this case, the postoperative complication of chylothorax was related to the complete dissection of tracheobronchial lymph nodes, which resulted in the extension of hospitalization and extubating time. Nevertheless, the chylothorax was resolved after active treatment and did not affect the surgical effect of the patient.

In conclusion, uniportal VATS left sleeve pneumonectomy is demonstrated to be a feasible procedure, however, it should be only performed for carefully selected patients by a much experienced operator. To the best of our knowledge, this is the first reported uniportal VATS left sleeve pneumonectomy in the world.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher’s website.

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FIGURE 3  Bronchoscopy 3 months after surgery