

# Thoracic surgery: single-port video-assisted thoracoscopic lobectomy

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**Abstract:** Single-port video-assisted thoracoscopic surgery (VATS) has been increasingly applied in clinical settings in the past two years along with the improvements in both endoscopic instruments and surgical skills. Our center began to perform single-port VATS lobectomy in May 2014 and had performed this procedure in 121 patients till January 2015. The surgical incision (3.5–4.5 cm in length) was created in the 4<sup>th</sup> or 5<sup>th</sup> intercostal space at the anterior axillary line at the diseased side. The operator stood at the abdominal side of the patient and operated using the endoscopic instruments only. The surgical steps of single-port VATS lobectomy were same as those of the triple-port VATS lobectomy. There was no fixed mode in handling the three major structures of the pulmonary lobes, and the resection sequence can be scheduled based on the development status of pulmonary fissures and on the difficulties in dissecting the relevant structures. We believe the single-port VATS lobectomy is a safe and feasible procedure and warrants further clinical applications after finishing these surgeries.

**Keywords:** Single-port; video-assisted thoracoscopic surgery (VATS); lobectomy

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## Introduction

Single-port video-assisted thoracoscopic surgery (VATS) has been increasingly performed in clinical settings along with the wide acceptance of the concept of “minimally invasive” and the improvements in both endoscopic instruments and surgical skills. The single-port VATS was initially reported by Migliore, who applied this technique in the diagnosis and treatment of noncomplex pleural disease (1). Our center began to perform this procedure for pleural biopsy in diagnosis of pleural diseases. Subsequently, we also employed this technique for some relatively simple thoracic surgeries such as thoracic sympathectomy, pleurodesis, resection of pulmonary bullae, and resection of mediastinal tumors. In recent years, our staff received further training on more advanced VATS procedures in both domestic and foreign institutions. We began to perform single-port VATS lobectomy in May 2014 and had performed this procedure in 121 patients till January 2015. Among them 106 patients had lung cancer and received systematic mediastinal lymph

node dissection.

## Operation techniques

All surgical procedures were performed under general anesthesia with double-lumen endotracheal tube placement for one-lung ventilation at the healthy side. The patients were placed in a lateral decubitus position (healthy side). The surgical incision (3.5–4.5 cm in length) was created in the 4<sup>th</sup> or 5<sup>th</sup> intercostal space at the anterior axillary line at the diseased side. The incision protector was applied in the port, and no distraction device was employed to distract the ribs. The operator stood at the abdominal side of the patient, and operated using the endoscopic instruments only. The camera-holding assistant may stand at the ipsilateral or contralateral side of the operator. The surgical steps of single-port VATS lobectomy were same as those of the triple-port VATS lobectomy. There was no fixed mode in handling the three major structures of the pulmonary lobes, and the resection sequence can be scheduled based

on the development status of pulmonary fissures and on the difficulties in dissecting the relevant structures. For patients with lung cancer, systematic mediastinal lymph node dissection was performed during the operation.

### *Single-port VATS right upper lobectomy*

Before the surgery, the patient was pathologically confirmed to be with invasive adenocarcinoma at the right upper lobe. Right upper lobectomy and mediastinal lymph node dissection were then performed. After thoracic cavity exploration, the pleura facing the right superior pulmonary vein was opened in front of hilum. The station 10 lymph nodes were removed after the hilum being released. Dissociated the first branch of the pulmonary artery and then transected it using the linear stapler. Thoroughly dissociated the upper lobe branch of the pulmonary vein and then transected it with the linear stapler. The right upper lobe bronchus was then exposed. After a sufficiently long bronchus being dissociated, it was clamped with the linear stapler; since the inspection showed that the residual lungs were well dilated, the bronchus was then transected. Opened interlobular fissure to expose the posterior segmental branch of the right superior pulmonary artery, and then transected it with the linear stapler. Divided the hypoplastic lung fissures using the linear stapler, and then removed the lung specimen. Opened the upper mediastinal pleura, and then dissected the lymph node stations 2R and 4R with the electrocautery hook and ultrasonic scalpel, then removed the lymph node station 9. Finally, dissected the lymph node stations 7 and 8 using the electrocautery hook and ultrasonic scalpel (*Figure 1*).

### *Single-port VATS right middle lobectomy*

The patient was found to be with non-peripheral hamartoma in the right middle lobe. Since it was difficult to perform wedge resection in this patient, right middle lobectomy was performed instead. After thoracic exploration, opened the anterior oblique fissure with the electrocautery hook and ultrasonic scalpel and then dissected the pleura surrounding the pulmonary vein to expose its middle lobe branch. Thoroughly dissected the three major structures in the right middle lobe, and then transected its vein, bronchus and artery one by one using the linear stapler. Finally, divided the hypoplastic horizontal fissure with the linear stapler (*Figure 2*).



**Figure 1** Single-port VATS right upper lobectomy (2). VATS, video-assisted thoracoscopic surgery.

Available online: <http://www.asvide.com/articles/508>



**Figure 2** Single-port VATS right middle lobectomy (3). VATS, video-assisted thoracoscopic surgery.

Available online: <http://www.asvide.com/articles/509>

### *Single-port VATS right lower lobectomy*

The lesion was pathologically confirmed to be invasive adenocarcinoma in the right lower lobe after the pre-operative CT-guided lung puncture. Right lower lobectomy and mediastinal lymph node dissection were then performed. After thoracic exploration, released the inferior pulmonary ligament and removed the lymph node station 9 and dissociated the inferior pulmonary vein. Opened the mediastinal pleura upwards and then dissected the lymph node station 7. Dissected the oblique fissure using the electrocautery hook and ultrasonic scalpel to expose the pulmonary artery and then divided the posterior oblique fissure with the linear stapler. After the basal and dorsal segmental arteries being thoroughly dissected and exposed, transected them with the linear stapler. Transected the right



**Figure 3** Single-port VATS right lower lobectomy (4). VATS, video-assisted thoracoscopic surgery.

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inferior pulmonary vein with the linear stapler. After the right lower lobe bronchus being dissociated, it was clamped with the linear stapler; since the inspection showed that the residual lungs were well dilated, the bronchus was then transected. Successively dissected the lymph node stations 10, 4R and 2R after removal of right lower lobe (*Figure 3*).

#### *Single-port VATS left upper lobectomy*

The lesion was pathologically confirmed to be an adenocarcinoma in the left upper lung. Left upper lobectomy and mediastinal lymph node dissection were then performed. After thoracic exploration, the inferior pulmonary ligament was dissociated till the inferior pulmonary vein level. Opened the mediastinal pleura in front of the hilum to expose the left superior pulmonary vein, followed by the removal of the lymph node station 5. Thoroughly dissociated the first branch of the pulmonary artery and then transected it using the linear stapler. Dissociated the left superior pulmonary vein and then transected it with the linear stapler. Dissected the interlobular fissure using the electrocautery hook and ultrasonic scalpel to expose the pulmonary artery and then transected two branches of the lingular segmental artery using the linear stapler. Ligatured the proximal end of the posterior segmental artery using the silk suture and then transected it with the ultrasonic scalpel. After the left upper lobe bronchus being dissociated, it was clamped with the linear stapler; since the inspection showed that the residual lungs were well dilated, the bronchus was then transected. After removal of the lung specimen, opened the mediastinal pleura in front of phrenic nerve and then dissected the



**Figure 4** Single-port VATS left upper lobectomy (5). VATS, video-assisted thoracoscopic surgery.

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**Figure 5** Single-port VATS left lower lobectomy (6). VATS, video-assisted thoracoscopic surgery.

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lymph node station 6, followed by the dissection of the lymph node stations 7 and 8. Finally, removed the lymph node stations 10 and 4L (*Figure 4*).

#### *Single-port VATS left lower lobectomy*

In this patient with bronchiectasis in the left lower lobe, left lower lobectomy was performed. The inferior pulmonary ligament was dissociated till the inferior pulmonary vein level. Dissected the interlobular fissure using the electrocautery hook, ultrasonic scalpel were used to expose the inferior pulmonary artery. Transected the basal and dorsal segmental arteries with the linear stapler. Thoroughly dissociated the inferior pulmonary vein and then transected it with the linear stapler. After the left lower

lobe bronchus being dissociated, it was clamped with the linear stapler; since the inspection showed that the residual lungs were well dilated, the bronchus was then transected (*Figure 5*).

## Discussion

In recent years, the Spanish thoracic surgeon Diego Gonzalez-Rivas reported a series of lung surgeries (e.g., lobectomy, segmentectomy, pneumonectomy, sleeve lobectomy, and pulmonary artery plasty) using the single-port VATS technique in peer-reviewed journals (7-13). Also, he demonstrated these single-port VATS surgeries in many international and domestic conferences. His efforts have dramatically promoted the development of single-port VATS technique. In Asia, this technique was initially performed and reported by surgeons in China's Taiwan Province and Hong Kong SAR (14-16). In 2014, some authors in mainland China also began to report their experiences in this procedure (17-19).

The application of VATS technique marked a milestone innovation in thoracic surgery. However, there is often a long learning curve for the conversion from the conventional open surgeries to VATS surgeries. While the triple-port VATS has been widely recognized, the adoption of the single-port VATS is more challenging: during the single-port VATS, the thoracoscope and all the surgical instruments pass in and out from the same port and therefore may interfere each other. The beginners need to gradually reduce the number of incisions and thus lower the surgical risks. For instance, Gonzalez-Rivas *et al.* initially used three ports, then two ports, and finally one port when their experiences became rich enough. In contrast, Liu *et al.* directly converted from the triple-port surgeries to single-port surgeries (19). Our team has performed triple-port VATS lobectomy in over one thousand of patients, which lays a solid foundation for the conversion into the single-port surgeries. Thus, we also directly converted from the triple-port technique to the single-port technique, and it took a short time for us to be familiar with the single-port VATS lobectomy.

According to our experiences in single-port VATS lobectomy in over 100 patients: (I) incision. The incision is typically created in the 4<sup>th</sup> or 5<sup>th</sup> intercostal space at the anterior axillary line at the diseased side. We had tried to create the incision in the 4<sup>th</sup> intercostal space in our earlier cases; however, the 5<sup>th</sup> intercostal space was then found to be more feasible in most cases except in chunky

individuals. The incision is 3.5-4.5 cm in length, and the incision at the muscular layer may be slightly longer than that the skin incision to facilitate the operation; (II) intra-operation cooperation. The surgery requires a close cooperation from an anesthesiologist to maintain the good collapse of the lung at the operated side. Furthermore, a close cooperation between the camera-holding assistant and the operator is particularly important. The camera-holding assistant may stand at the ipsilateral or contralateral side of the operator. According to our experiences, if the camera-holding assistant stands at the contralateral side of the operator, he/she will have less body contact with the operator and thus the operator could operate in a more comfortable way; (III) camera. The camera (30°, 10 mm in diameter) used in our surgery is same as that used in triple-port VATS. However, thinner and bendable cameras will be more feasible for the single-port VATS. The camera head is often located at one end of the incision, in particular the upper edge, so as to minimize its interference on the surgical instruments. The camera body should be vertical to the incision, so as to save the operation room. Towel clip can be used to fix the camera body, so as to increase the stability of the camera and reduce the camera-holding assistant's fatigue; (IV) surgical instruments. The surgical instruments during single-port and triple-port VATS are basically the same. However, bendable instruments such as double-joint vascular clamps can facilitate operations, reduce the interferences among instruments, and shorten the surgical duration; and (V) chest tube placement. In our earlier cases, the placement of chest tube was same as the open surgeries or triple-port lobectomy, two chest tubes were placed after upper lobe resection and one chest tube was placed after middle or lower lobe resection. They were all placed via the same incision. However, we then found such a placement method is not ideal for drainage. In two cases, pleural space drainage was performed again after the surgery. Furthermore, placement of two chest tubes in the same incision not only increases the pain but also affects incision healing. Later, we placed one chest tube (#28) in the incision. Based on the resection site, the chest tube can be placed beneath the ribs. In addition, a thin tube (Abel drainage tube) was placed in the 8<sup>th</sup> or 9<sup>th</sup> intercostal space at the posterior axillary line. The thick tube was withdrawn if there was no air leakage, and the thin tube can remain till the fluids became fewer. By doing so, the drainage effectiveness is satisfactory, and the patients feel more comfortable.

All the patients had been followed for more than one



month, no perioperative major morbidity and mortality was noted. Thus, we believe the single-port VATS lobectomy is a safe and feasible procedure and warrants further clinical applications.

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