



## Uniportal Video-Assisted Thoracoscopic Tracheal Resection

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### Abstract

Thoracotomy or video-assisted thoracic surgery (VATS) with 3 to 4 incisions is the traditional way to perform a tracheal resection for tumors of the lower third of the trachea, but it also can be performed using only one incision. We describe surgical technique of uniportal video-assisted thoracoscopic tracheal resection. The patient had a VATS approach through a 3 cm incision in the fourth intercostal space without rib spreading. Continuous suture was used for trachea anastomosis successfully. Traction sutures were used to help anastomosis. Pathological examination revealed trachea adenoid cystic carcinoma with length of 0.5 cm and 0.7 cm respectively. The patient had good general conditions without any respiratory symptom 3 months after operation.

**Keywords:** Uniportal; VATS; Tracheal resection; Continuous suture

### Introduction

In clinical studies adenoid cystic carcinomas and bronchogenic carcinomas are by far the most common primary tumors, most of them need surgery. For tumors of the lower third of the trachea where it is advisable to dissect a wider lateral margin, where a greater extent of trachea may have to be resected, or where hilar mobilization may be required, a trans-thoracic approach was preferred. Thoracotomy or video-assisted thoracic surgery (VATS) with 3 to 4 incisions is the traditional way to perform a tracheal resection, but it also can be performed using only one incision. We describe surgical technique of uniportal video-assisted thoracoscopic tracheal resection.

### Technique

A primary tracheal tumor was diagnosed in a 62-year-old woman with symptoms of cough and wheeze. Preoperative evaluation included a computed tomographic scan (CT) of the chest and abdomen, cranial magnetic resonance, fiber-optic bronchoscope, and pulmonary function test (FEV<sub>1</sub>/FVC was 71.8%, and the MVV was 86.4 L/min). Two lesions with wide base could be seen in fiber-optic bronchoscope, each distance from carina was 2.0 cm and 2.5 cm, the superior margin was 6.5 cm away from vocal cord (Figure 1). Adenoid carcinoma was diagnosed by biopsy. Chest CT revealed tracheal lesions at the anterior wall without extramural extent or lymphadenopathy (Figure 1). Uniportal VATS was the proposed approach for the patient. The local ethical committee judged that the study protocol was conformed to the institution policy.

We placed the patient in a left lateral decubitus position. Combined intravenous anesthesia was achieved using a single-lumen 6.5-mm endobronchial tube (Covidien, Iic, Mansfield, MA) intubation. A single incision of approximately 3 cm was made in an intercostal space between the right anterior axillary line and mid axillary line at the fourth intercostal space without rib spreading (Figure 2). We placed the camera at fully rearward position in the posterior portion of the incision, with instruments working at its anterior direction. The azygous vein was first dissected and divided. The mediastinal pleura was opened from superior margin of right hilus of lung to the apex, then paratracheal lymph nodes were removed.

Bronchoscope was performed to precisely define the region of tracheal lesions, and chose optimal margins segment for resection (about 1 cm away from lesion) (Figure 3A), suspension sutures were used to grasp and elevate the trachea. The vertical sutures were placed through the partial thickness in the cartilage through cartilage rings to avoid penetrating the whole trachea into the lumen. Trachea segment was mobilized with blunt dissection and ultrasonic scalpel (Ethicon, Inc, Somerville, NJ) with attention to protect vagus nerve and vena cava. Four tracheal rings were removed. Inferior margin was cut first and a 6.0-mm endobronchial tube was inserted into distal trachea (Figure 3B). An endobronchial tube was inserted into distal trachea through the incision; the tube was dragged by a sling along with endoscope to avoid interfering with all other instruments.

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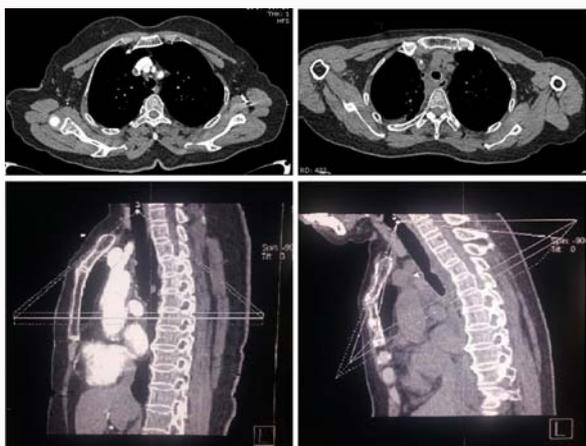
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**Figure 1:** Two lesions with wide base could be seen in fiberoptic bronchoscopy. Chest CT revealed tracheal lesions at the anterior wall without extramural extent or lymphadenopathy. Postoperative Chest CT showed good anastomosis and smooth trachea inner surface.



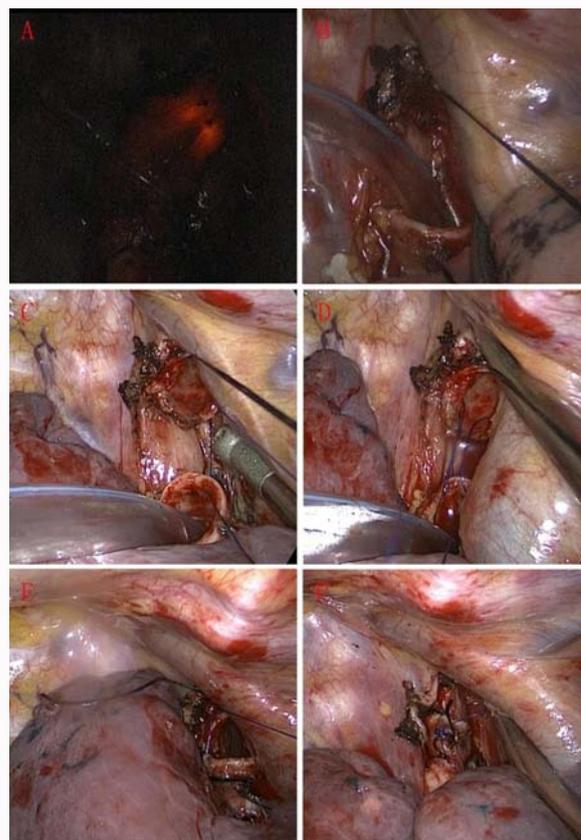
**Figure 2:** The patient had a VATS approach through a 3-cm incision in the fourth intercostal space without rib spreading.

Since adenoid cystic carcinoma is characterized by submucosal spread and the lesions were 5 mm distant one from the other, we cannot differentiate between two separate lesions and a single tumor precisely. The margins were selected based on endoscopic observation and fast frozen pathology. The tracheal lesions were completely removed at the suture sites. Intra-operative frozen section analysis showed that the surgical margin was negative. The limit of tension was carefully judged to be accepted as being safe for the anastomosis.

Care must be taken not to injure the left recurrent laryngeal nerve as it lies on the aortic arch just beyond the left posterolateral tracheal wall.

The end-to-end anastomosis was started by lifting suspension sutures to pull the tracheal margins close. Prolene suture (3-0) (Ethicon, Somerville, NJ) was used for continuous sutures to close bronchial membrane and cartilage, it started at the anterior cartilaginous-membranous junctions (Figure 3C) and achieved whole anastomosis from anterior to posterior for membrane (Figure 3D) and from posterior to anterior for cartilage (Figure 3E). It is quite important and challenging that each suture should be pulled at a certain tension to avoid tangling.

During anastomotic suturing the endotracheal tube was withdrawn intermittently. Before continuous sutures were totally completed, tube in distal trachea was removed and the original tube was inserted. The sutures were dragged tight to close trachea without knotted, anastomosis air leak was tested by submerging it under saline. The sutures were tied down tight at one time using device after



**Figure 3:** Sequence of trachea anastomosis. Bronchoscope was performed to precisely define the region of tracheal lesions, and chose optimal margins segment for resection (about 1 cm away from lesion) (A). Inferior margin was cut first and a 6 mm endobronchial tube was inserted into distal trachea with help of dragging suspension suture (B). Anastomosis started at the anterior cartilaginous-membranous junctions (C) and achieved whole anastomosis from anterior to posterior for membrane (D) and from posterior to anterior for cartilage (E). The sutures were knotted at one time after confirmation of no air leak existence (F).

confirmation of no air leak existence (Figure 3F). The anastomosis could accept 30 cmH<sub>2</sub>O to 35 cmH<sub>2</sub>O ventilatory pressure without leakage. The anastomosis was visualized with a flexible bronchoscope passed through the endotracheal tube. Mediastinal pleura was applied to cover the anastomosis site. Drainage was left; tip of tube was located at the trachea anastomosis site.

## Result

The surgery time was 185 minutes. Intraoperative blood loss was about 50 ml, and the intraoperative oxygen saturation was maintained above 95%. Blood gas analysis showed that intraoperative SpCO<sub>2</sub> was about 45 mmHg without acidosis. Patient was mechanically ventilated after the surgery for 2 h, and successfully extubated. Drainage tube was removed on the fourth postoperative day.

Patient controlled analgesia fentanyl pumps were given for the first and second postoperative day, then patient required only oral analgesia (oral tramadol) for 7 days. Mild local paraesthesia adjacent to the wound was reported, which resolved by the 1-month visit.

The patient was discharged on the sixth postoperative day without surgery-related complications or other notable events. One month later, Chest CT showed good anastomosis and smooth trachea inner surface, bronchoscope was not performed because the patient

refused to take this examination (Figure 1). Pathological examination revealed trachea adenoid cystic carcinoma with length of 0.5 cm and 0.7 cm respectively. The patient went well without any respiratory symptom 3 month after operation, pulmonary function test was performed, the FEV<sub>1</sub>/FVC was 75.5%, and the MVV was 87.4 L/min.

## Discussion

The first report of VATS tracheal resection appeared 8 years ago [1]. The surgical approach for distal trachea or carinal resections should be either right thoracotomy or median sternotomy, however, this procedure can be performed by multiport or uniportal VATS when in expert hands. There are few reports of VATS tracheal resection performed with no direct visualization and no rib retractor. Most of the authors describe the VATS approach with 3 to 4 incisions, but the surgery can be performed by only 1 incision with similar outcomes [2]. Since 2013, we have used the uniportal approach for VATS lobectomy and other complex cases as experience accumulated. According to our experiences, uniportal VATS procedures have many advantages; less pain might be suffered by patients and lead to faster recovery.

When dividing the airway at the site selected, completely encircling the trachea was usually difficult. Division of the cartilaginous arch all the way back to the membranous trachea on both sides was preferred, first dissection of the membranous wall off the trachea might be easier to have adjacent tissue injured.

When the endotracheal tube was withdrawn, a second endobronchial tube was needed to maintain respiratory. High frequency jet ventilation (HFJV) was an alternation to avoid interference with sutures, however, there were concerns that the use of HFJV could contribute to acute respiratory distress syndrome, it was more suitable for tracheal operations requiring a small operative area and a short anastomotic time [3].

Suspension sutures were an ideal way for both tracheal resection and anastomosis. Proximal and distal airways were easily mobilized with sutures dragged high, it also benefit for tube insertion to distal trachea. The sutures produced a direct effect on the anterior cartilage, making anastomosis easier when trachea in an angle instead of laying flat in uniportal VATS. Caution must be taken to avoid distortion of the airway due to excessive tension on the sutures [4].

Most of reports describe the VATS approach using interrupted sutures in anastomosis, or combine interrupted with continuous sutures, especially in bronchus cartilage reconstruction [4]. The end-to-end anastomosis could also be performed by complete continuous suture, either through multiportal or uniportal VATS [5]. It was an ideal way to avoid tangling. Besides, tension could be carefully

adjusted with a sliding knot-pushing instrument or simply dragging sutures tight. This technique could provide a better operative view. We dragged tight and knot sutures after anastomosis air leak were tested, which could enable additional sutures when small air leak was found.

Non-intubation technique under spontaneous breathing brought more benefits to patients, it might be more convenient for surgical manipulation without interference of trachea tube, however, not all patients were suitable for this technique [6].

Rigid bronchoscopy may help in planning surgical management providing a more precise delineation of the tracheal lesion or resection and allowing a better control of potential post-biopsy bleeding, however, in this case, adenoid carcinoma was diagnosed by biopsy and the lesions did not obstruct trachea lumen, operation was preferred.

## Conclusion

With the accumulation of uniportal VATS experience, the list of absolute and relative contraindications to uniportal VATS has shrunk. More clinical experience should be accumulated to investigate advantage of uniportal VATS tracheal resection and other complex tracheal and bronchial surgery.

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