Double sleeve uniportal video-assisted thoracoscopic lobectomy for non-small cell lung cancer

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Double sleeve (vascular and bronchial) lobectomy is a reasonable alternative to pneumonectomy in patients with centrally located tumors involving the pulmonary artery and bronchus. However, it is a challenging and complex procedure even when performed through thoracotomy.

Despite the advances in thoracoscopic surgery, double sleeve lobectomy by conventional thoracotomy is still the preferred approach because of the technical difficulties of thoracoscopic surgery and the potentially increased operative risks even when performed by experienced video-assisted thoracoscopic surgery (VATS) surgeons. There are very few reported cases of double sleeve lobectomy by VATS using 3-4 incisions (1,2). We present the first report of double VATS sleeve resection by a single incision approach.

Clinical tummary

A 65 year-old male, smoker, was diagnosed with a 7.2 cm left upper lobe adenocarcinoma with vascular and bronchial involvement. The patient received neoadjuvant Platinum based chemotherapy (six sessions) with poor response. A chest computed tomography (CT) scan performed before surgery (*Figures 1* and *2*) showed progression of the tumor (9 cm mass with left upper lobe atelectasis) despite neoadjuvant chemotherapy. The patient was offered left upper lobe resection with uniportal VATS.

Surgical technique

Under general anesthesia, we performed flexible video bronchoscopy. The right-sided airways had normal anatomy with no endobronchial lesions and no significant amount of secretions or pus. In the left-sided airways, there was an obvious tumor mass that had completely occluded the entire orifice of the left upper lobe of the lung and was entering the distal left main bronchus.

The patient was positioned into right lateral decubitus position with the left side up, and a VATS approach using a 5 cm single-incision was made in the 5th intercostal space with no rib spreading (no soft tissue retractor and no direct vision).

The upper lobe was adherent to the chest wall, the mediastinum, and the aorta without signs of invasion, and was detached and freed of its adhesions using cautery. Digital palpation confirmed the presence of a 9 cm mass occupying most of the upper lobe and involving all arterial branches of the upper lobe. There was no other evidence of pleural disease in the chest.

The first step was to expose and control the main pulmonary artery (PA), which was dissected and encircled with a double vessel loop, while the superior pulmonary vein was also dissected free and transected using endostaplers. We then opened the fissure between the upper and lower lobe. The tumor did not involve the fissure or the lower lobe and the artery was dissected and mobilized.

The left main bronchus and the lower lobe bronchus were dissected and cleared, with dissection of the subcarinal lymph node and subsequently the interlobar and peribronchial lymph nodes up towards the specimen. The main bronchus and left lower lobe bronchus were transected with a long handle No. 10 blade (sleeve resection). The inferior pulmonary ligament was released to allow greater mobilization of the lower lobe. Before clamping of the PA, 5,000 units of heparin were given intravenously to prevent clotting. The main PA was occluded using a thoracoscopic D'Amico clamp (Scanlan International, MN, USA) and

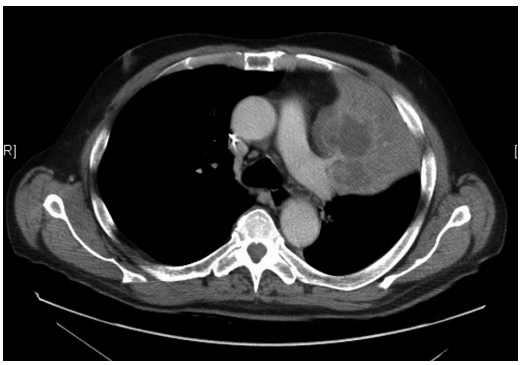

Figure 1 Computed tomography scan after chemotherapy showing arterial involvement.

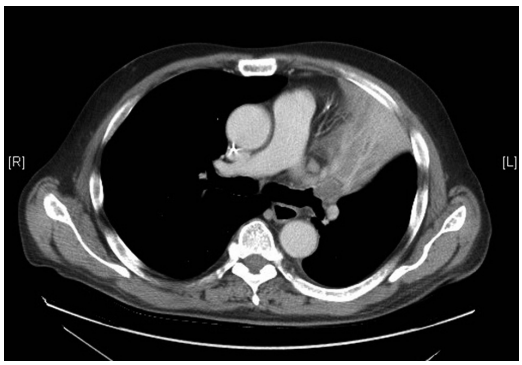

Figure 2 Computed tomography scan after chemotherapy showing bronchial involvement.

the interlobar artery was occluded with a bulldog clamp (Aesculap, Inc., Center Valley, PA, USA). The main PA and the basal artery were transected with scissors (vascular sleeve) to remove the left upper lobe en-block. The specimen was temporarily placed in the lower chest cavity above the diaphragm. We started the double sleeve reconstruction by the bronchial anastomosis using a running, non-absorbable suture (PDS 3/0) for cartilaginous and membranous portions. The posterior wall of the bronchus was sutured first, the anterior wall was sewn up last, and then both sutures were tied together. The lower lobe was inflated and no air leakage was detected underwater. The arterial sleeve anastomosis was performed thereafter by using a monofilament non-absorbable continuous suture (prolene 4/0) in two different rows, with a similar method as for the bronchus (the medial arterial wall was sutured first, followed by the lateral wall). Both suture lines were tied together at the anterior part of the anastomosis using a thoracoscopic knot pusher.

The edges of the anastomosis were everted to enhance arterial intimal interface and maximize the opening of the anastomosis. The bulldog clamp was opened for back bleed to remove the air, and the inflow and outflow were flushed and checked prior to the anastomosis. The clamp from the main PA was slowly opened and no bleeding from the vascular anastomosis was found.

The bronchial anastomosis was then wrapped with a piece of oxidized regenerated cellulose (Surgicel®), to be isolated from the vascular suture. The specimen was inserted into a protective plastic bag and removed by enlarging the incision. A single chest tube was placed at the end of the operation. Frozen section confirmed that all surgical margins were clear, including our bronchial and left main stem bronchus margin. The total surgical time was 260 min and estimated blood loss was 170 cc.

Patient recovery was satisfactory, and the chest tube was removed on the 5th postoperative day. Pathological examination revealed a 7.5 cm adenocarcinoma with bronchial and vascular involvement (free tumoral margins) and no lymph node malignancy (pT3N0M0).

Discussion

The thoracoscopic approach for major lung resection for advanced lung cancer is now gaining wide acceptance worldwide (3). However, lobectomies requiring double sleeve are challenging procedures, even when performed by thoracotomy. As such, it still remains a contraindication for VATS approach, even for experienced thoracoscopic surgeons, primarily due to concerns of vascular injury during thoracoscopy as well as the technical complexity of the procedure for an optimal bronchovascular reconstruction. There are few articles published in the literature describing a double bronchial and vascular sleeve reconstruction by VATS, and all of these cases are reported by using 3-4 incisions (2,3). VATS sleeve lobectomies are still being refined.

Through recent technical advances in VATS lobectomy (instruments and HD cameras) and the skills and experience gained from treating large numbers of patients, these complex procedures can be performed by using only a single incision approach. As a result, advanced procedures such as uniportal sleeve lobectomy (4,5) or uniportal vascular reconstruction (6) have already been published with good postoperative outcomes (7). The advantage of uniportal VATS surgery is that it allows the target tissue to be directly

visualised at a similar angle of view as for open surgery (8). Conventional multi-port VATS triangulation creates a new optical plane for the genesis of a dihedral or torsion angle not favorable with 2D monitors. Another advantage of the uniportal VATS technique is that instruments are inserted parallel to the video-thoracoscope, therefore mimicking the maneuvers performed inside the chest during open surgery. This geometric uniportal VATS concept facilitates the double bronchial and vascular anastomosis in complex resections such as the one described in this article.

The use of thoracoscopic instruments with proximal and distal articulation is very useful for sleeve procedures through a single incision approach, especially for clamping the pulmonary artery and for suturing the artery and bronchus. The use of a bulldog clamp placed inside the chest cavity for clamping the basal artery allows surgeons to have more space for instrumentation through a single incision approach. The clamp for the main artery is placed in the anterior portion of the incision and the camera in the posterior portion, making the instrumentation similar as for an open approach for bronchial and vascular anastomosis.

With the single incision thoracoscopic view, the bronchus is located behind the artery, making it easier to perform bronchial anastomosis first, followed by arterial, in order to avoid excessive manipulation and traction to the arterial suture.

Several reports confirm the safety of bronchovascular reconstructions after chemotherapy (9). Video-assisted thoracoscopic sleeve procedures enable faster patient recovery and preserve pulmonary function (10,11). This is especially important in patients receiving induction treatment, as the implementation of a pneumonectomy would increase the rate of postoperative complications (12). In the current literature, there is also evidence supporting the use of neoadjuvant treatment and minimally invasive techniques.

In conclusion, single incision thoracoscopic bronchovascular double sleeve lobectomy is technically difficult, but feasible, when performed by skilled surgeons experienced with the uniportal approach.

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