Visualized Surgery

# Right upper lobectomy performed as dividing posterior ascending artery-bronchus-pulmonary vessels is alternative to primary indolent scar carcinomas

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**Abstract:** We describe a case of pulmonary indolent malignancy requiring a strategic surgery and introduce an alternative technique of right upper lobectomy via video-assisted thoracic surgery (VATS) for primary lung cancer patients. A 42-year-old male non-smoker was referred to the hospital following the detection of an opacity with a cystic airspace in the right upper lobe during a routine physical examination. During a regular follow-up over 3.5 years, the solid component enlarged and the cystic wall thickened. Based on a suspicion of indolent scar carcinoma, a right upper lobectomy was performed using VATS. The preoperative diagnosis was clinical T1bN0M0, stage Ia primary lung cancer. Our surgical procedure, posterior single-direction aBVA, consists of dividing the posterior ascending artery branch and then the right upper bronchus, followed by the right upper pulmonary vessels. By efficiently reducing the operation time and blood loss, our method is potentially superior to conventional right upper lobectomy.

**Keywords:** Video-assisted thoracic surgery (VATS); right upper lobectomy; pulmonary carcinomas; posterior ascending branch; right upper bronchus

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## Introduction

Video-assisted thoracic surgery (VATS) has been the standard treatment for early-stage non-small-cell lung cancer (NSCLC). A large proportion (37.2%) (1) of pulmonary cancers occur in the right upper lobe and are treated surgically by right upper lobectomy (RUL), which takes into account the complicated anatomical structure of the right upper lobe. In the single-direction approach of Liu *et al.* (2), the pulmonary vessels and then the bronchus are divided as in conventional RUL, but in both methods, problems with the hilar structures are encountered. Yan (3) summarized a reliable posterior approach, in which first the posterior ascending artery branch and then the right upper bronchus are divided, followed by the pulmonary vessels. However, in this method the surgeon stands posterior to the patient, which requires greater manipulation of the lobe, increasing the risk of vessel injuries. Since 2010, we have used VATS to perform RUL according to a technique that we refer to as posterior single-direction aBVA, in which first the posterior ascending artery branch is divided, followed by the bronchus and the pulmonary vessels.

Several different strategies for treating small nodules in the lungs have been described. Veronesi *et al.* (4) performed a cohort study evaluating the volume-doubling time (VDT) according to changes in the size and solid components of the nodules on sequential low-dose computed tomography (CT) screening. Slow-growing (VDT, 400–599 days) and indolent (VDT ≥600 days) tumors comprised approximately 25% of incident cases. Many of these may have been over-diagnosed and should have been dealt with by minimally invasive limited resection or even nonsurgical treatment. Indolent pulmonary cancers comprise ground glass

 


**Figure 1** Visualized surgery of RUL via VATS as aBVA. The first part of the video introduced briefly the definition and strategies of pulmonary indolent malignancies. With high suspicion of pulmonary malignancies based on naked vision of wedge resection, the surgeon dissociated the posterior ascending branch and hilar structures while waiting for the pathologic results of frozen sections. Then after the confirmation of pulmonary adenocarcinoma, the RUL was operated with the dissecting order of the posterior ascending branch (*a*), followed by the right upper bronchus (*B*) and vessels (veins and arteries, VA) (aBVA). RUL, right upper lobectomy; VATS, video-assisted thoracic surgery; aBVA, posterior ascending artery branch-right upper bronchus-right upper veins and arteries (6).
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opacities (GGO), solid and cystic nodules, the pathological morphology of which is usually a lepidic pattern, as well as carcinoids and scar adenocarcinomas. Farooqi *et al.* (5) reported a case of a 56-year-old male smoker who had a nodule with a cystic airspace and thin wall in the right lower lobe. The patient was followed up for 33 months, at which time the CT scan showed enlarged solid components and a thickened cyst wall. The pathological diagnosis, based on surgical tumor tissues, confirmed adenocarcinoma surrounding the entire cystic airspace. Their study thus warned of the possible development of a pulmonary malignancy subsequent to the detection of a solitary cystic airspace with increasing wall thickness. Here we describe a patient who, after implementing a "wait and see" approach, was diagnosed with pulmonary indolent scar carcinoma that was then surgically treated.

## Clinical data

A 42-year-old male non-smoker was referred to Guangdong General Hospital (China) due to a lesion in the right upper lobe detected during a routine physical examination. The first positron emission tomography/CT (PET/CT) scan, performed in November 2011, showed a solitary cavitary lesion in the right upper lobe. During regular follow-up for 3.5 years, no radiological signs of malignancy were identified until June 2015 when the solid components in the wall of the carcinomatous cavity had enlarged (2.1 cm, SUV max =1.7), but without any local or distant metastases. Suspicion of indolent scar carcinoma led to the decision of RUL via VATS. The preoperative tumor stage was clinical T1bN0M0, stage Ia.

## Operative techniques

The patient received double-lumen endotracheal tube intubation for unilateral lung ventilation under general anesthesia and was placed in the standard left lateral decubitus position. Specific details of this surgical procedure are provided in (*Figure 1*).

One access incision (3–4 cm) was made along the anterior axillary line in the fourth or fifth intercostal space (ICS), with an additional camera port (1–1.5 cm) located on the posterior axillary line one ICS lower than the access incision (*Figure 2*) and without rib spreading. A plastic wound protector was applied to prevent implantation metastasis, and an additional suction tube was fixed to maintain a clear surgical field. The procedure was facilitated by the use of a high-definition 30° thoracoscope, which broadened the horizons through the camera port. An electrocoagulation hook designed by Xue-Ning Yang was used in a sharp dissection of the anatomical structures. Other instruments included a powered Echelon stapler, a curved suction device, double-jointed forceps, lymphatic node forceps, and an endoscopic grasper for grasping small gauze pads.

The sole surgical assistant stood on the dorsal side of the patient, holding the thoracoscope. The surgeon stood on the ventral side, holding the curved suction in his left hand to assist exposure and dissociation by the electrocoagulation hook or endoscopic stapler which was held in his right hand.

The surgery began with exploration of the lesion located in the right upper lobe and exclusion of intrathoracic dissemination. An extended wedge resection was performed with a surgical margin of 2 cm from the lesion. After sufficient tumor tissues had been obtained for pathological diagnosis, additional tumor tissues, paraneoplastic and normal lung tissues were resected for storage in our tumor specimen bank for subsequent analysis of their gene profiles.

 

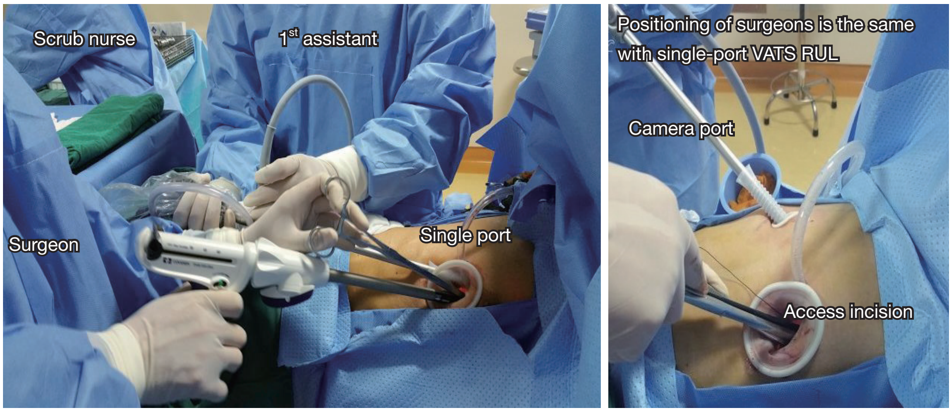


**Figure 2** Positioning of surgical and nursing teams during RUL as aBVA. (A) Single-port; (B) double-port. RUL, right upper lobectomy; aBVA, posterior ascending artery branch-right upper bronchus-right upper veins and arteries.

After the visceral pleura at the crossover of the horizontal and posterior oblique fissure was dissected, the interlobar lymph nodes at that site were explored. These nodes are usually regarded as a landmark to avoid injuries to the posterior ascending branch of the right upper artery. While pushing the right upper lobe to the inferior side with the curved suction, the surgeon used the electrocoagulation hook to open the superior mediastinal pleura, to identify the apico-anterior arterial trunk and dissociate the superior hilar (station 10) lymph nodes. The posterior mediastinal pleura was then opened up to the point of the oblique fissure, to expose the wedge of the right upper bronchus. A blunt dissection was performed using curved forceps, followed by manual establishment of a tunnel running through the oblique fissure back to the posterior hilum. Facilitated by the traction of a silk thread, an ENDO-GIA45/3.5 cm stapler was inserted into the tunnel, and the posterior oblique fissure was dissected. The right upper lobe was displaced superiorly and anteriorly, allowing dissociation of the station 12 lymph nodes. The anterior mediastinal pleura was opened between the right upper and middle pulmonary vein by the electrocoagulation hook. Another manual tunnel was made through the anterior to posterior hilum, facilitating the division of the fused horizontal fissure using an EGIA60AXT stapler.

Once the pathological results of the intraoperative frozen section confirmed pulmonary invasive adenocarcinoma, an ENDO-GIA30/2.5 cm stapler was used to divide the posterior ascending branch of the right upper artery (*a* in the aBVA) by displacing the right upper lobe superiorly and anteriorly to further expose the artery. The posterior mediastinal pleura was opened to the edge of the right upper bronchus. An ENDO-GIA45/4.8 cm stapler was used to close and then dissect the right upper bronchus (*B* in aBVA) once the well-inflated right middle and lower lobes were identified when bilateral lung ventilation was performed by the anesthetist. Afterwards, the remaining adhesions around the hilum were freed as much as possible. The lobar and hilar lymph nodes should be dissociated to the distal end of the pulmonary vessels or just divided to minimize the thickness of residual hilar structures. An EGIA45AVM stapler was then used to divide the remaining branches of the pulmonary arteries and veins simultaneously (*VA* in aBVA) (*Figure 3*).

Next, the right upper lobe was removed using a specimen bag to minimize contact with the incision and to eliminate the possibility of implantation metastases. The N1 and N2 lymph nodes were removed using systematic node dissection based on standard principles. Warm normal saline was used for thorough washing, and a chest tube was inserted through the camera port, as in conventional procedures.

Pathological diagnosis based on the paraffin-embedded tumor tissues confirmed pulmonary invasive adenocarcinoma with a combined acinar (80%) and papillary (20%) growth pattern [pT1bN0M0, stage Ia; World Health Organization Classification, 2015, (7)]. Gene profiles showed that the tumor was negative for epidermal growth factor receptor (EGFR) and ALK expression.

## Comments

Our alternative RUL procedure using VATS called the posterior-single aBVA approach, whose general principle is to proceed from the central to the peripheral hilar anatomical

 

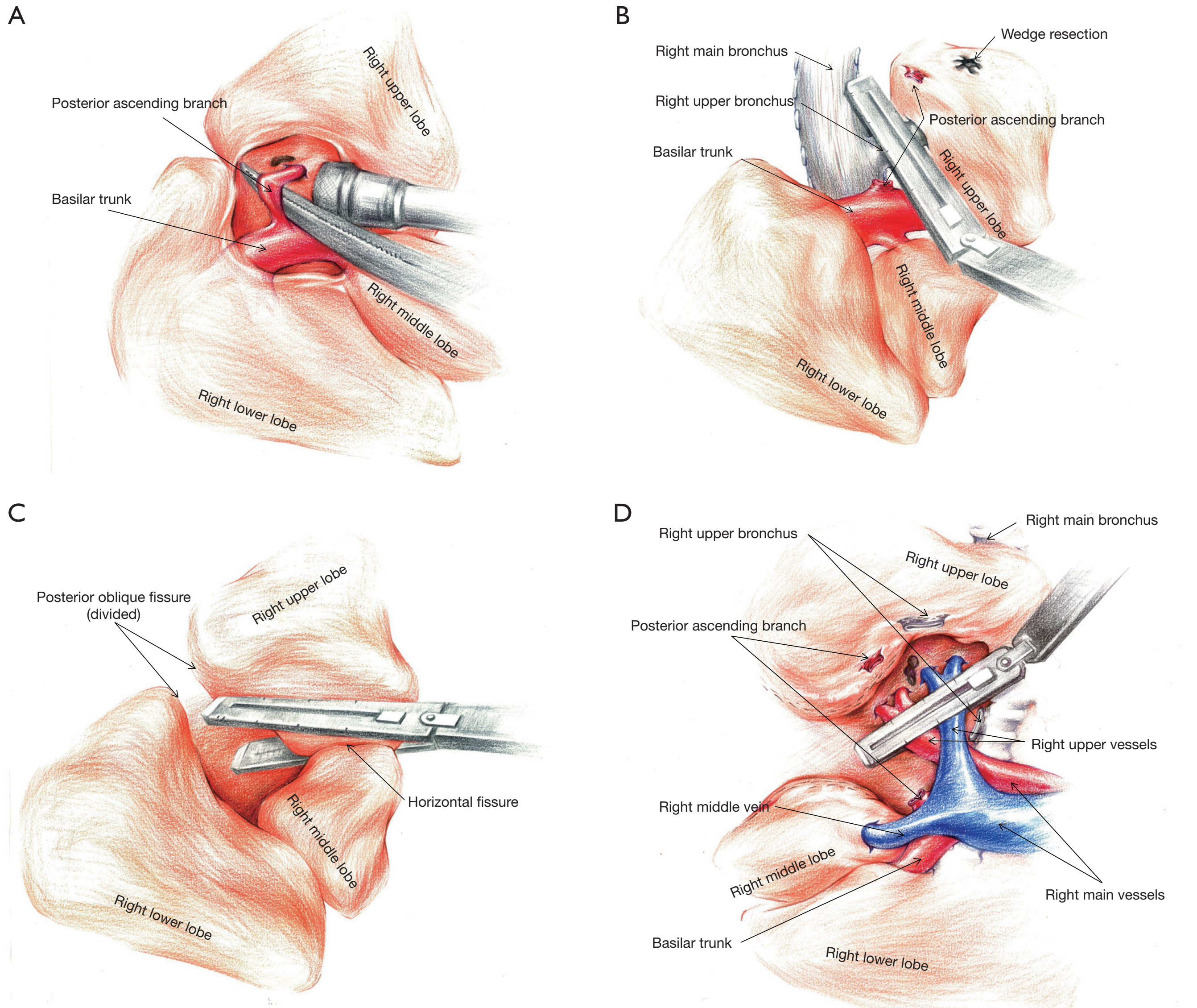


**Figure 3** Four key steps of RUL via VATS as aBVA. RUL, right upper lobectomy; VATS, video-assisted thoracic surgery; aBVA, posterior ascending artery branch-right upper bronchus-right upper veins and arteries. A, Division of the posterior ascending branch; B, Division of the right upper bronchus; C, Division of the horizontal fissures; D, Division of the right upper veins and arteries.

structures (*Figure 3*). The visceral pleura at the crossover of the oblique and horizontal fissures is opened first, to identify and subsequently dissect the posterior ascending branch of the right upper artery (*a* in the aBVA). The oblique fissure is then divided for better exposure of the right upper bronchus, which in patients with totally fused fissures should be divided last. An electrocoagulation hook is used to open the mediastinal pleura posteriorly, superiorly, and anteriorly, accompanied by dissociation of the hilar lymph nodes and identification of the pulmonary vessels. The right upper bronchus (*B* in aBVA) is then dissected using a stapler. Subsequent division of the horizontal fissure is facilitated by the manual establishment of a tunnel; incomplete fissures should be divided during the last step. Residual hilar structures are dissociated as much as possible, either sweeping the hilar and lobar lymph nodes to the distal end of the lobe or dissociating them. A stapler is used to dissect the remaining pulmonary arteries and veins (*VA* in aBVA).

To some extent, the efficient use of specific instruments optimized our surgical procedure. The electrocoagulation hook designed by Xuening Yang has a small obtuse angled hook (145° from the longitude axis) at its apical end. With the electrocoagulation hook's combined function of cutting and coagulating, the surgeon can carry out sharp, subtle dissections and quick hemostasis during the operation. Moreover, the electrocoagulation hook is sufficiently long with high plasticity, which aids in overcoming surgical difficulties at anatomic sites of high angularity.

Our alternative aBVA procedure has been performed using a double- or single-port (*Figure 2*) in hundreds of patients. Statistical analyses have confirmed its advantages compared with conventional surgical methods, including: (I) a shorter average operation time and less blood loss (8); (II) lower risks of conversion to open thoracotomy, and more evidence of the reliability, feasibility and safety of the procedure; (III) shorter intubation duration and postoperative hospitalization, promoting fast postoperative recovery; and (IV) fewer postoperative complications. The potential difficulties of aBVA are (I) the identification of the posterior ascending branch of the right upper artery; and (II) the division of fused fissures through a manual channel. In addition, the procedure demands the surgeon's familiarity with hilar anatomical structures.

In summary, we demonstrated the technical feasibility, safety and effective application of the aBVA, a reliable and reproducible VATS RUL procedure. Its effectiveness will be validated as it is used to treat additional candidate patients with right upper lobe carcinomas requiring RUL.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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