

# Resection of the sidewall of superior vena cava using video-assisted thoracic surgery mechanical suture technique

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**Abstract:** Lung cancer invading the superior vena cava (SVC) is a locally advanced condition, for which poor prognosis is expected with conservative treatment alone. Surgical resection of the lesion can rapidly relieve the symptoms and significantly improve survival for some patients. Replacement, repair and partial resection of SVC via thoracotomy were generally accepted and used in the past. As the rapid development of minimally invasive techniques and devices, partial resection and repair of SVC are feasible via video-assisted thoracic surgery (VATS). However, few studies have reported the VATS surgical techniques. In this study, we reported the crucial techniques of partial resection of SVC via VATS.

**Keywords:** Vena cava; resection; video-assisted thoracic surgery (VATS); lung cancer; surgery

Submitted Dec 06, 2015. Accepted for publication Jan 18, 2016.

doi: 10.21037/jtd.2016.01.55

**View this article at:** <http://dx.doi.org/10.21037/jtd.2016.01.55>

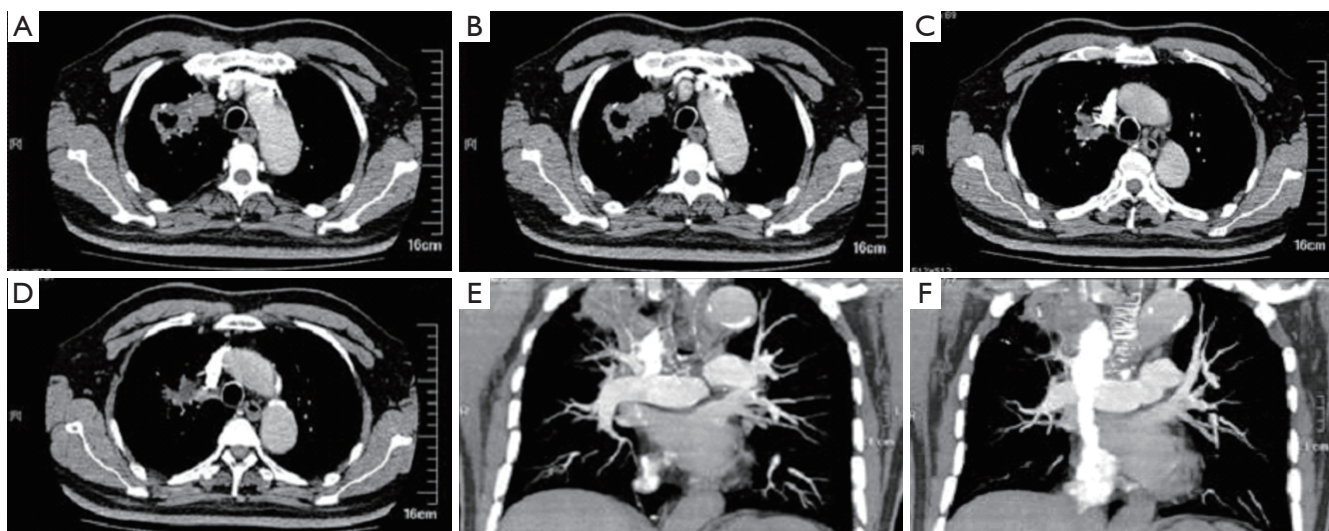
## Introduction

Lung cancer invading the superior vena cava (SVC) is a locally advanced condition, for which poor prognosis is expected with conservative treatment alone. Surgical resection of the lesion can rapidly relieve the symptoms and significantly improve survival for some patients, and long-term survivors are not uncommon. In the past, for cases with lung cancer invading SVC, traditional surgery can be done through resection and replacement of SVC (including simple removal and replacement of SVC, and replacement of bilateral innominate veins), repair of SVC, and partial resection of SVC wall followed by direct closure (1). Using the traditional method, the removal of SVC requires occlusion of a part of the sidewall by a clamp or complete occlusion of the vessel from the proximal to distal ends. When a video-assisted thoracic surgery (VATS) manual suture technique is applied, many surgical devices need to pass through the minimally invasive incision(s); in addition, the suturing needs to be performed using needle holders. Thus, this technique is highly challenging for most

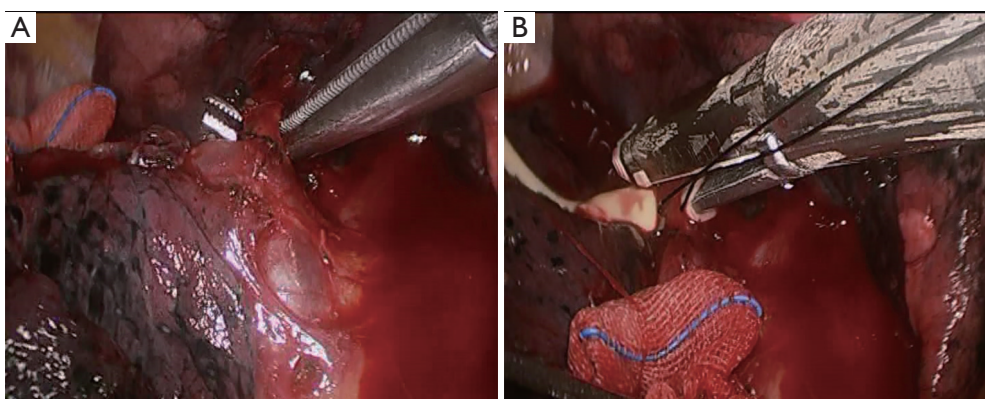
thoracic surgeons. However, few articles have described the application of complete VATS for the tumors invading SVC, and its surgical modes and skills require further investigations. Automatic mechanical suturing enables the direct resection of the sidewall of SVC and avoids the blockage of SVC and manual suturing, thus reducing the difficulty of minimally invasive surgery.

## Case presentation

The case selection criteria were as follows (2): (I) the general condition of the patient is good, the functions of various organs are normal, and thus the patient can tolerate a surgery; (II) preoperative examinations confirm that there is no distant metastasis or positive N3; (III) in patients being N2 node-positive, if there is no obvious fusion or metastasis to multiple stations, surgical resection may be applied in those with localized lymph node metastasis; (IV) the range of invaded SVC should be no more than 1/6 of its circumference (*Figure 1*).



**Figure 1** Preoperative computed tomography (CT) scan showed central mass of right upper lobe and the supra cava vena was partially invaded by the mass.



**Figure 2** The procedure of right upper lung vein dissection. (A) Continue the dissection to expose the upper lobe branch of right upper lung vein; (B) transect the upper lobe branch of right upper lung vein using the endoscopic cutter/stapler.

### *Anesthesia*

After the induction of general anesthesia, the patient was under double-lumen endotracheal intubation.

### *Body position*

The patients were often placed in a lateral decubitus position on the unaffected side. The waist bridge is elevated to maximize the intercostal spaces and thus facilitate the operation.

### *Surgical procedures*

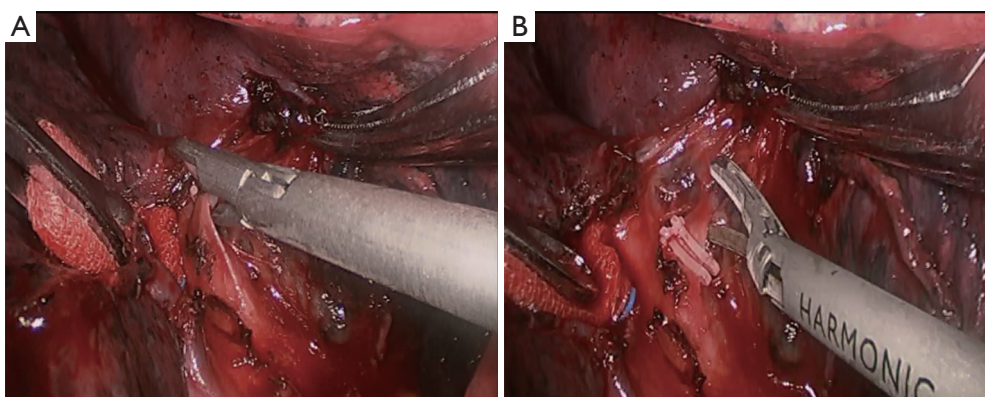
Incisions: typically three incisions will be more feasible.

Observation port (incision): in the 6<sup>th</sup> or 7<sup>th</sup> intercostal space at anterior axillary line, about 1 cm in length. Main operation incision: in the 3<sup>rd</sup> or 4<sup>th</sup> intercostal space at anterior axillary line, about 4 cm in length. Auxiliary operation incision: within the same intercostal space with the observation port; in the 6<sup>th</sup> or 7<sup>th</sup> intercostal space at posterior axillary line, about 1 cm in length.

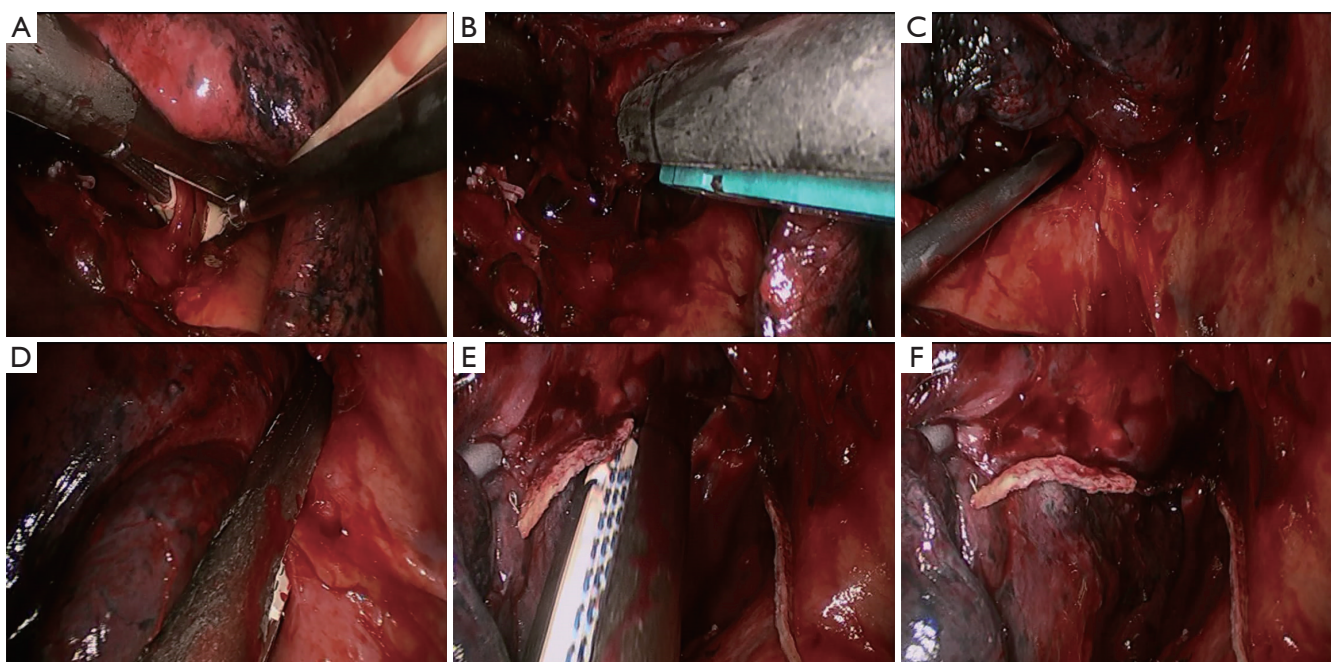
### *Surgical steps*

The pulmonary fissure is cut open to expose the upper lobe branch of the right upper pulmonary vein, which is then transected using the endoscopic cutter/stapler (*Figure 2*). To





**Figure 3** Expose the branch of right upper lobe artery and transect the branch. (A) Expose the branch in the posterior segment of right upper lobe; (B) transect the arterial branch in the posterior segment of the right upper lung vein using the endoscopic cutter/stapler.



**Figure 4** The procedure of right upper lobe artery dissection and partial superior vena cava (SVC) resection. (A) Transect the first branch of right lung artery using endoscopic cutter/stapler; (B) transect the right upper lobe bronchus using the endoscopic cutter/stapler; (C) only its adhesion to the SVC was not handled; (D) place the endoscopic cutter/stapler (white reload); (E) fire the endoscopic cutter/stapler to remove the sidewall of SVC; (F) cutting edge.

facilitate the stapler to pass through the intervascular space, a silk suture can be used to lift the vein and the endoscopic cutter/stapler can be guided by a urinary catheter.

Dissect to expose the pulmonary arterial branch in posterior segment of the right upper lobe and then transect it with high intensity focused ultrasound (HIFU) after it is blocked off with vascular clamps (*Figure 3*). To ensure

the safety, the proximal end is usually blocked off using two vascular clamps, while the distal end of the pulmonary arterial branch can be directly transected using HIFU.

Expose the first branch of the right upper pulmonary artery, which is then transected using the endoscopic cutter/stapler (*Figure 4*). To facilitate the stapler to pass through the intervascular space, the endoscopic cutter/stapler can

still be guided by a urinary catheter. Transect the right upper lobe bronchus.

Under general anesthesia with double lumen tube, resection of the sidewall of SVC using VATS mechanical suture technique was performed on August 18<sup>th</sup> 2010 (*Figure 5*).

### Postoperative computed tomography (CT)

The SVC was patent and no stricture was found. The right middle bronchial anastomosis was patent (*Figure 6*).

### Discussion

The method used in this study has two key technical



**Figure 5** Resection of the sidewall of SVC using VATS mechanical suture technique (3). SVC, superior vena cava; VATS, video-assisted thoracic surgery.

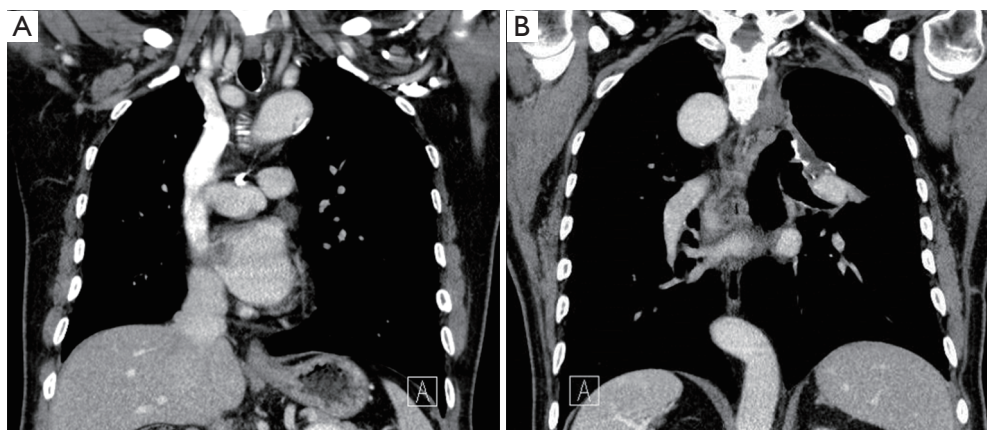
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concerns: first, how to ensure safe resection without bleeding margins of the sidewall, and second, how to ensure thoracoscopic resection with negative margins while maintaining sufficient blood reflux in the residual vessel.

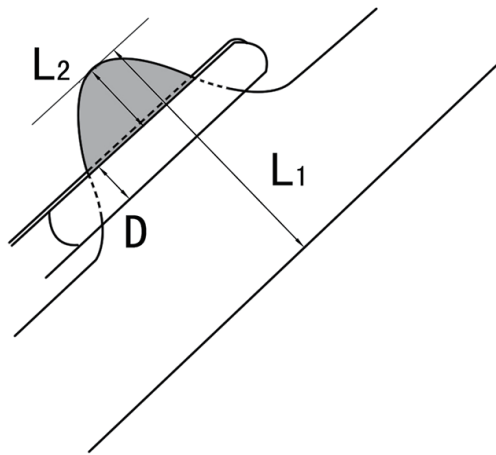
Regarding the first technical issue, in thoracoscopic lung surgery, cutting blood vessels of different diameters and thicknesses with a stapler is a common operation, such as cutting the pulmonary artery, pulmonary vein, or even azygos vein. From a technical point of view, resection of the sidewall of the SVC with a stapler is essentially nothing different from handling the pulmonary artery, pulmonary vein or even azygos vein of different diameters. Therefore, we do not worry whether the cutting margin can be properly stapled and if bleed leakage occurs. In view of the experience with operations for the latter, we did not administer systemic heparin during the surgery or routine anticoagulation after it.

Regarding the second technical issue, since the present cohort had advanced lung cancer, the surgery was relatively complex, and the surgical indications should therefore be properly observed. From the technical view for minimally invasive surgery, we are most concerned about the length and the circumference of invasions in the SVC, especially the latter. To this end, we need to be careful in selecting eligible cases. In our current case, the inclusion criteria were mainly based on the diameter of SVC and the width of endoscopic cutter/stapler (take Ethicon Echelon Flex 60 as an example) (*Figure 7*):

$$\frac{\text{width of invaded SVC}}{\text{SVC circumference}} < 1/2 - \frac{\text{width of endo-stapler}}{\text{half of SVC circumference}}$$



**Figure 6** The postoperative computed tomography (CT) scan.



**Figure 7** The demonstration of partial superior vena cava (SVC) resection:  $L1 = 1/2 \text{ diameter} = 1/2 (\pi \times \text{diameter of superior the vena cava})$ ;  $L2 = \text{width of invaded SVC}$ ;  $D = \text{width of stapler}$ .

in which the width of the endoscopic linear cutter/stapler is about 1 cm. Since the SVC diameter is about 2 cm in most Chinese patients, the range of the invaded SVC should be less than  $1/6$  of the circumference. As for a patient with a large body size, or a more delicate stapler can be used, this

**Cite this article as:** Xu X, Qiu Y, Pan H, Mo L, Chen H, He J. Resection of the sidewall of superior vena cava using video-assisted thoracic surgery mechanical suture technique. *J Thorac Dis* 2016;8(3):612-616. doi: 10.21037/jtd.2016.01.55

range can be further expanded.

### Acknowledgements

None.

### Footnote

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

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