

## Mini Review

# Extended Segmentectomy for Small Lung Nodule with Image-Guided Video-Assisted Thoracoscopic Surgery

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## Introduction

In this decade, the technique of image-guided Video-Assisted Thoracoscopic Surgery (iVATS) has become more and more popular. Previous studies proved that iVATS is a safe and feasible way to remove Solitary Pulmonary Nodules (SPNs) and improve patient care [1].

Several studies have discussed in detail the experience of iVATS with cone-beam CT. The learning curve, patient's position, single incision, localization material, dual-marker technique and bilateral resection were reported [2,3]. However, the applications of iVATS for central lung nodules and segmentectomy have not been explored.

Here, we describe a novel technique using iVATS to accomplish extended segmentectomy for central lung nodules. This technique helps to overcome the challenges of nodules situated at the intersegmental area. In traditional thoracoscopic segmentectomy, it is hard to make a safe margin for these nodules.

## Surgical Technique and Patient Results

The Institutional Review Board (IRB) of our hospital approved this study and informed consent was waived by our institute's IRB. Under general anesthesia, patients were positioned in the lateral decubitus position in a hybrid operating room. All lines and tubes were secured and taped. We used robotic C-arm cone beam CT (Artis Pheno; Siemens Healthcare GmbH, Forchheim, Germany) for the scanning. Before the scanning, we performed a test C-arm movement to ensure the scanner would not collide with the patient. The entire scan was performed with breath hold at end inspiration by clamping the endotracheal tube.

We measured the shortest nodule distance to the pleura point

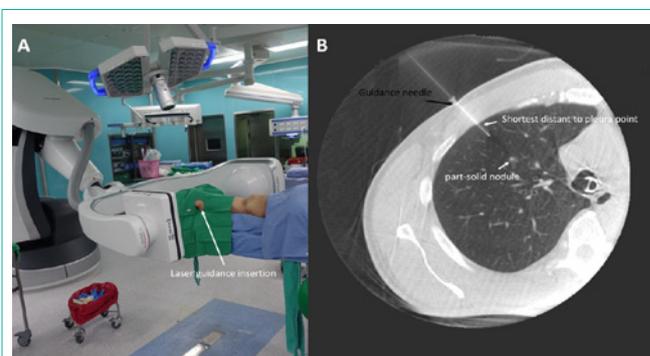
### Abstract

Patients with clinical T1aN0M0 Non-Small Cell Carcinoma (NSCLC) or poor pulmonary function may benefit more from segmentectomy compared to lobectomy. However, there is question about segmentectomy provides not enough safe margin, especially for nodules situated at the intersegmental area. We describe a novel technique using image-guided Video-Assisted Thoracoscopic Surgery (iVATS) to accomplish extended segmentectomy for central lung nodules. This technique helps to overcome the challenges of nodules situated at the intersegmental area.

**Keywords:** Extended segmentectomy; Image-guided video-assisted thoracoscopic surgery; Non-small cell carcinoma; Resection margin

at axial view and laid out the needle path under the syngo Needle Guidance of a syngo X-Workplace with a three-dimensional view. We set the guidance needle to a depth around 10mm in the pleura toward the nodule. A cross laser beam for incision location was projected onto the patient's skin. We punctured an 18-gauge marker needle into the thorax with the cross-laser guidance after breath holding (Figure 1a). After another scan for confirmation of the appropriate needle location (Figure 1b), diluted methylene blue dye (0.15ml) plus normal saline (0.25ml) were injected. The purpose of this volume helped methylene blue dye to see within 5-millimeter diameter on the surface of the lung and not to color the nodule. The operation started after sterilization and one lung ventilation.

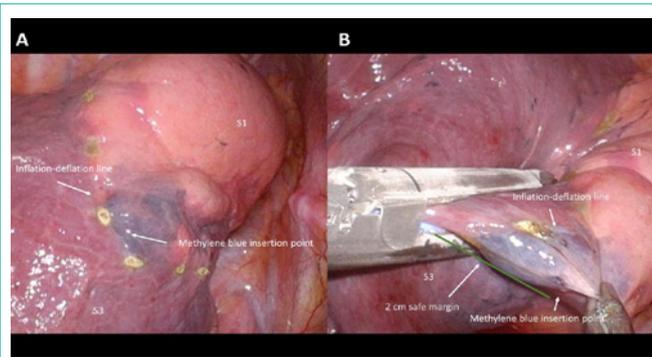
We performed extended segmentectomy with single-incision



**Figure 1:** The procedure of image-guided Video-Assisted Thoracoscopic Surgery (iVATS) was displayed.

**a:** An 18-gauge marker needle was punctured into the thorax with cross-laser guidance after breath holding.

**b:** Confirmation the needle was located at shortest distance to the pleura point.



**Figure 2:** The extended segmentectomy was performed with the guidance of methylene blue.

**a:** Methylene blue insertion near right S1/S3 intersegmental line.

**b:** Measure at least 2cm resection margin to methylene blue insertion point.

VATS. Most of the methylene blue dye could be seen clearly on the surface of the lung. After segmental bronchus division, we identified the inflation-deflation line and the nodule site (Figure 2a). A safe margin of 2 centimeters away from the nodule site was created and divided by linear stapler (Figure 2b).

We defined the extended segmentectomy as resection margin greater than 2cm or greater than the size of the nodule as National Comprehensive Cancer Network (NCCN) guideline recommendation. We successfully performed extended segmentectomy *via* the iVATS technique in 57 patients with central lung nodules situated at the intersegmental area. For each patient, creating a safe margin during traditional segmentectomy would have been difficult. In these 57 patients, the mean distance to the pleura was 2.55 centimeters. All the nodules had a safe margin of at least 2 centimeters. None of the patients needed further intensive care unit stay.

## Discussion

For central lung nodules, thoracoscopic lobectomy is the standard surgical treatment. Although an increasing number of studies suggest that segmentectomy may provide equivalent outcomes in stage IA non-small cell carcinoma (NSCLC), there are questions about not enough safe margin, especially for nodules situated at the

intersegmental area. However, segmentectomy can preserve lung function and have acceptable outcomes for early lung cancer [4]. Patients with clinical T1aN0M0 NSCLC or poor pulmonary function may benefit more from segmentectomy compared to lobectomy.

This iVATS technique with extended segmentectomy provides the distance from the tumor location to the inflation-deflation line. Thus, insufficient safe margin does not need to be a concern during iVATS surgery. A previous study showed that extended segmentectomy could provide comparable outcomes to lobectomy for clinical T1aN0M0 NSCLC, especially when nodules are less than 5 mm or located at the superior segment [5]. After applying the iVATS technique to extended segmentectomy, all of our 57 patients had 2 to 3 cm resection margins. We believe that this more delicate technique has feasible outcomes and preserves more pulmonary function than lobectomy does.

To the best of our knowledge, this is the first study to use an iVATS technique for extended segmentectomy. Fifty-seven patients have received this procedure thus far, and the peri-operative outcomes appear promising. However, long-term follow-ups and outcomes are still needed.

## References

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